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COST EFFECTIVENESS STUDY OF WASTEWATER MANAGEMENT SYSTEMS FOR SELECTED U.S. COAST GUARD VESSELS

Volume III - Installation Analysis

Part 4 - PAMLICO (160')

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1700 Broadway
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February 1977

FINAL REPORT

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UNITED STATES COAST GUARD
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16. Abstract

Each of the 18 candidate Wastewater Management System (WMS) configurations developed in Volume IV was analyzed for installation aboard the PAMLICO (WLIC - 800). The following information was developed: vessel conditions including locations of black water (sewage and garbage grinder slurry) and gray water (galley and turbid) waste sources, vessel/resources capacities and estimated usage rates, determination of viable candidate systems based on installation guidelines and assumptions developed in Volume IV, black and gray wastewater (or sludge) holding tank capacities which can be fitted, installation cost estimates for each viable candidate system, arrangement drawings for WMS equipment and waste sources, installation related effectiveness attribute data.

The analysis was performed in three stages. A preliminary installation analysis was made on the basis of vessel plans available. Since a shipcheck of this vessel could not be scheduled in time for this analysis, the "As Built" drawings and other vessel data provided by the Coast Guard were substituted. The final step consisted of a more detailed analysis of each viable candidate system to develop installation cost estimates and other required installation related information including arrangement drawings and effectiveness attribute data. Cost estimates were developed using a form which analyzes each viable candidate system in terms of standard installation cost elements, each of which has an assumed unit cost.

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Volume III. Installation Analysis.
Part 4. PAMLICO (160').

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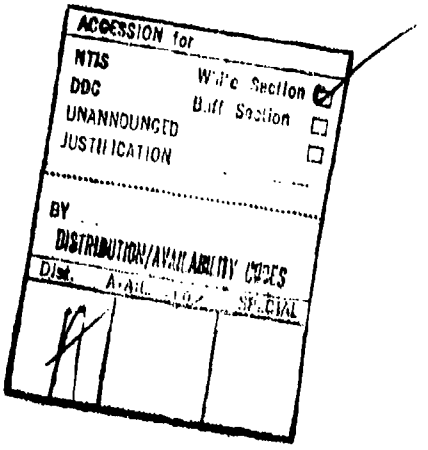
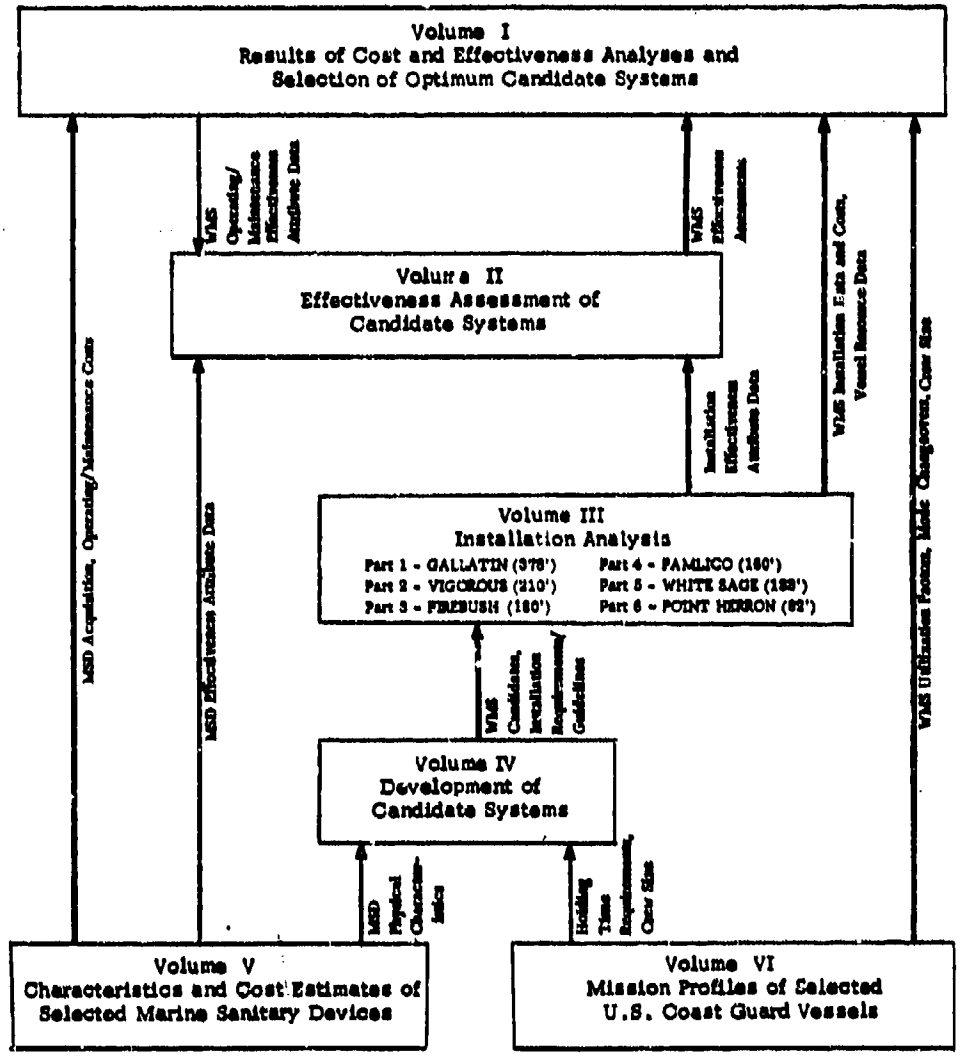
The installation analysis was performed in consultation with George G. Sharp, Inc., 100 Church Street, New York, N.Y. 10007.

The cooperation and assistance of the officers of U.S. Coast Guard Cutter PAMLICO (WLIC-800) in providing the requested vessel data is greatly appreciated.



PREFACE

The relationship among the volumes of the report is depicted below. This relationship does not convey all the information contained within each volume.



SUMMARY OF WMS INSTALLATION COSTS

Vessel: PAMILCO (160')

WMS No.	TYPE: Coll/Trans Subsys (Black)	TYPE: Treatment/Disposal Subsystem: Black	TYPE: Treatment/Disposal Subsystem: Gray	Holding Capacity: Black (%)	Holding Capacity: Gray (%)	INSTALLATION COST ($)
1	Gravity Collect.	Holding Tank	Holding Tank	100	55	28,520
2	Oil Recircul. (Chrysler)	Chrysler + Hld Tnk	Holding Tank	100	64	25,290
3		Chrysler + Incin.	Holding Tank	100	64	30,590
4	Gravity Collect. (Grumman)	Grum Flow Thru+HldTk	Holding Tank	100	64	24,280
5		Grumman Flow Thru + Holding Tank		100	100	15,220
6	Gravity Collect.	Holding Tank	Grum Flow Thru+HldTnk	100	100	21,200
7	Gravity Collect. (Grumman)	Grum Flow Thru+Incin.	Holding Tank	100	64	29,230
8		Grumman Flow Thru + Incinerator		100	100	18,030
9	Vacuum Collect. (Jered)	Holding Tank	Holding Tank	100	64	19,890
10		Incinerator	Holding Tank	100	64	21,370
11		GATX Evap.	Holding Tank	100	64	15,830
12		Holding Tank	Grum Flow Thru+ Hld Tnk	100	100	12,760
13		Incinerator	Grum Flow Thru + Incin.	100	100	14,470
14	M/T Pump Collect. (GATX)	Holding Tank	Holding Tank	100	64	20,490
15		Incinerator	Holding Tank	100	64	22,940
16		GATX Evap.	Holding Tank	100	64	17,770
17		Holding Tank	Grum Flow Thru+Hld Tnk	100	100	13,480
18		Incinerator	Grum Flow Thru + Incin.	100	100	13,080

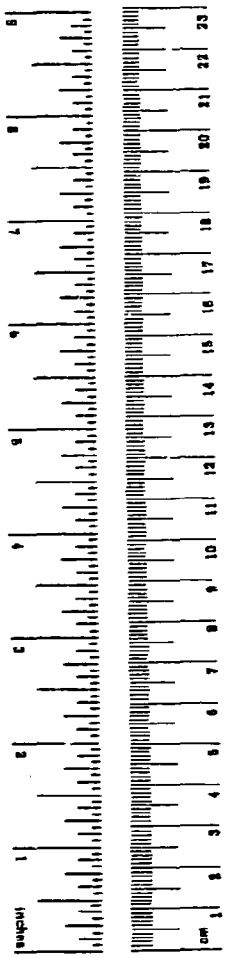
N/A - Not a viable candidate system for this vessel.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

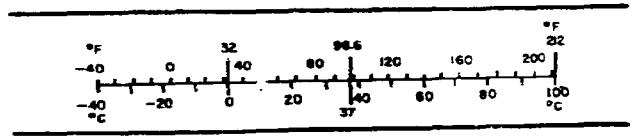


TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

INTRODUCTION

OBJECTIVES

The objectives of the installation analysis are as follows:

- Development of pertinent vessel information necessary for the cost and effectiveness analyses, including the following:
  - Existing physical conditions aboard the vessel, especially in compartments where wastewater management system equipments may be installed.
  - Existing wastewater management equipments/systems aboard the vessel (holding tanks, garbage grinders, sewage treatment systems, etc.).
  - Location of black and gray wastewater sources aboard the vessel.
  - Vessel resource capacities and estimated usage rates (prior to system installation).
- Selection of the viable candidate systems as determined on the basis of the feasibility of installation, using the governing installation guidelines and assumptions.
- Determination of the black/gray wastewater (or sludge) holding tank capacities which can be fitted.
- Development of installation cost estimates for each viable candidate system.
- Development of drawings showing the proposed arrangement of the wastewater management system equipments for each viable candidate as well as the arrangement of the black and gray wastewater sources on board the vessel.
- Development of installation related effectiveness attribute data.

ASSUMPTIONS

The pertinent assumptions and guidelines governing the installation analysis are presented in Volume IV of this report, along with the details of each of the 18 candidate wastewater management system concepts in configurations suitable for each vessel included in this study.

APPROACH

The installation analysis was performed in three stages consisting of a preliminary installation analysis, a shipcheck to establish viable system/vessel combinations, and an installation cost analysis all of which are discussed below. Prior to this analysis, visits were made to a number of vessels to inspect installations of the wastewater management subsystems and equipments included in this study.

Preliminary Installation Analysis

The candidate ship's general arrangement drawings and piping diagrams as furnished by the U.S. Coast Guard were reviewed at length to determine existing conditions so that the WMS requirements delineated in Volume IV could be applied to the vessel and a preliminary installation analysis made prior to an actual visit to the ship. This approach was intended to maximize familiarity with the vessel and to determine any possible questionable areas of interest. Each system was investigated as to space requirements, possible equipment locations, relationship to ship's functions (operation, mission, fuel stowage, water capacity, support systems, etc.) and its relationship to the reportedly existing waste disposal system.

In order to obtain as accurate a picture as possible, arrangement drawings to scale were made from the ship's plans of the possible installation spaces and "dummy cut-outs" of WMS equipment (also to scale) were used to determine if a proposed arrangement was feasible and if any problems could be anticipated. The results of the preliminary installation analysis are presented in Appendix A.

Shipchecks To Determine Viable Candidate Systems

Upon completion of the preliminary installation analysis, a detailed shipcheck of the vessel was made. During this visit various factors bearing on the investigation were considered, e.g., support systems (compressed air, sanitary flushing medium, electrical power generation, salt water systems, fresh water systems, fuel oil systems, etc.), correlation between actual ship arrangement and that shown in ship's drawings furnished for the study, relationship of other ship's systems and equipment to the location

and installation of WMS components to determine interferences and relocations, access for shipping WMS equipment aboard, removals, relocations, etc. The drawings prepared during the preliminary installation study were checked out and modified to reflect actual shipboard conditions.

The discussion of the shipcheck results presents a verbal picture of what conditions actually exist aboard the vessel and how these conditions affect the viability determination of each wastewater management system. The installation acceptance or rejection rationale for each candidate WMS is presented, complete with estimated tank sizes, equipment locations, possible space modifications, relocations, limitations, exclusions, and any other such considerations as may be necessary to obtain a lucid understanding of the situation.

Vessel resource capacities (including the source of fresh water) and estimates of usage rates (prior to WMS installation) were obtained from interviews with cognizant officers. The locations of all black water (sewage and garbage grinder slurry) and gray water (galley and turbid) waste sources were determined.

The shipcheck also provided the necessary information to determine the capacities (in gallons) of required black and gray wastewater (or sludge) holding tanks (not part of manufacturer supplied wastewater treatment equipment) which can be accommodated, as well as their configurations (heights). This information was used to determine the black and gray wastewater holding capacities of each viable candidate system (expressed as a percentage of the required holding time). These results are presented on the WMS Equipment Requirements form together with the other equipment types and quantities required in order to synthesize each viable candidate system on the vessel. This WMS Equipment Requirements form served as the starting point for the cost and effectiveness assessments of each viable candidate system.

Installation Cost Analysis

The following were generated as part of the installation cost analysis:

- WMS equipment arrangement drawings for each viable candidate system and arrangement drawings for the black and gray wastewater sources aboard the vessel.
- Installation related effectiveness attribute data.
- Installation cost estimates for each viable candidate system.

The starting point for the installation cost estimates was the condition of the vessel at the time of the shipcheck inspection. Each viable candidate system installation was then analyzed in terms of a fixed set of installation cost elements. The Installation Cost Estimate Form shown in Figure 1 was used to record the estimated requirements for each cost element and the associated cost was computed. Each installation cost element in Figure 1 is discussed below.

(a) Piping - Wherever possible and applicable, existing piping runs were retained for reuse as installed. Pertinent information contained in the available ship's piping plans was used insofar as practicable. New piping runs were estimated from these drawings and the system equipment arrangement drawing prepared.

For estimating purposes of this nature, it is usual marine practice to use a dollars per pound of material to be installed. Therefore, an estimated present-day price, including material and labor to install, was placed at $4.50/lb.

For the sake of uniformity and simplification since the WMS evaluations are comparative, the piping material used is copper-nickel. It is recognized that most waste disposal piping systems under consideration in the U.S. Coast Guard vessels are of copper-nickel, although some PVC (plastic) piping and a small amount of steel is used. Since the established guidelines call for the principal piping (drainage) to be of copper-nickel it was considered that for the relatively small additional piping, such as vents, the use of copper-nickel for all piping components would not adversely influence the overall results. Accordingly, the amounts of each size piping were estimated and a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.

(b) Steel - For this part of the cost estimate only the steel involved in the various shipyard supplied tanks is considered. Foundations are a separately treated item. For these tanks it was considered that one-quarter inch plate would be a good average thickness. Since the tanks would have to be structurally stiffened for proper support, a factor of 30% was added to the plate weight. The weight estimate was derived from the system guideline size requirements translated into configurations as shown on the equipment location and arrangement drawings.

For cost estimating of this nature, it is usual to apply a cost per pound figure. It was considered that a good current price of $0.55/lb. would cover material and labor for fabrication and placing on board. This does not include the cost of fixing the tanks permanently in place by welding. This is a separate consideration.

WMS INSTALLATION COST ESTIMATES

Vessel_____

WMS No._____

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	[2]	
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	[4]	
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	[5]	
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)		
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)		
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)		
Welding		Feet	$ 6.00/Ft. (Materials and Labor)		
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)		
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)		
Total Installation Cost ($)					

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

Figure 1

INSTALLATION COST ESTIMATE FORM

(c) Foundations - Supporting steel structure for all components of each WMS (tanks, pumps, MSD, incinerators, etc.) was estimated as approximately 10% of the weight which has to be carried. This is a usual rule of thumb for this type of installation. Fabrication and installation costs for material and labor were taken as $0.92/lb. based on consideration of today's average costs. The weights were estimated from the tank configurations and contents as well as the component weights given in Volume IV.

(d) Electrical Power Cable - The amount of footage was estimated from the ship's arrangement plans and the WMS equipment arrangement drawings prepared, with allowances for the devious routings which could be encountered. Since ship alteration work is usually more complex than new construction, allowance as made for less installation per unit time. Therefore a cost of approximately $2.00/ft. of cable was used to cover material and labor.

(e) Miscellaneous Installations - To cover the installation of various items such as pumps, motors, skid-mounted components, etc. where the activity centers principally around alignments and bolting in place, an estimate was made of the amount of time it would take to perform the tasks for each system installation, since the number and type of components varies. An estimated shipyard labor cost of approximately $15 per man-hour (MH) was considered representative.

(f) Access Cuts - In order to get material and components into the compartments where they would be fitted it could become necessary to temporarily cut the ship's hull, or deck plating or a bulkhead to provide passageway. The number of feet of cutting was estimated for each system installation based on the approximate size of the largest component anticipated. Estimated shipyard cost for such cutting is approximately $1.00/ft.

(g) Welding - This consideration includes securing tanks and non-bolted items and welding back any plating temporarily cut to provide access. An estimate of the number of feet of welding was made for each item in each system and a cost factor of $6.00/ft was considered satisfactory to cover material and labor.

(h) Removals - In cases where some existing equipment would have to be cut and removed from the vessel as no longer required, an estimate was made as to the approximate length of time it would take a team of two men to accomplish certain tasks. Estimated factors of $50/hour for cutting (based on an estimated cutting note of 50 ft/hour) and $15/man-hour (MH) for miscellaneous handling labor were considered representative of such costs.

(1) Other Considerations - The installation cost estimates do not include some shipyard costs which yards to include as a matter of quotation to perform a certain ship modification. Such intangibles would include: cleaning and gas-freeing tanks, temporary removals or modifications to ducts, piping, electric cables, machinery, ship's outfit or furnishings, etc. and re-installation to existing state after the basic modification has been completed; cleaning, preparing and repainting the compartments and parts of the steel work distrubed, use of special rigging and shipyard lifting gear; and other work items which are part of a hipyard's everyday business and which are normal for them to price out.

If a complete ship alteration price is desired, it would involve drawing up a complete set of specification and drawings in sufficient detail for a shipyard's estimating department to analyze at length. If possible, yard personnel would prefer to visit the vessel for a more accurate cost estimate to eliminate or minimize costs which it could possibly have to absorb.

One of the most difficult factors to consider and which is not obvious but which is very much a determinant is the shipyard's workload or backlog. If there is a convenient "hole" in the yard's work schedule, the price could be made attractive since it would provide needed economic continuity for its work force and facilities. Certainly if there is little or no other work in the offing, the yard will be inclined to "buy" the job by bidding lower than it normally would.

Thus it can be seen that there will be additional costs to those detailed herein, if one is interested in a "finished product" price than a comparative estimate.

LIMITATIONS

The installation cost estimating procedures used are considered to be fairly general and applicable for study purposes of this type which places greater emphasis on relative cost among candidate systems rather than on the absolute cost for a given system. However, the installation cost estimates developed herein are based on specific vessel conditions, wastewater management system requirements and the governing installation guidelines and assumptions. Therefore, caution is advised in attempting to use these estimates directly for vessels and/or systems other than those specifically included in this study.

PERTINENT VESSEL INFORMATION

PAMLICO (160')

New Construction

Vessel Characteristic	Data
Class	WLIC - 800
Type	Construction Tender (Inland)
Crew Size	13
Home Port	New Construction (Intended for Operation in Depot Corpus, Texas)

SHIPCHECK OBSERVATIONS OF EXISTING VESSEL CONDITIONS

PAMLICO (160')

Crew 13 men

Waste Sources

Complete information on the sewage and gray water waste sources is contained in the tabulation sheets forming a part of these introductory remarks.

Existing Arrangment

The sanitary flushing medium is fresh water provided by two fresh water service pumps with a hydropneumatic tank.

Compressed air is supplied by independent system compressors; viz. ship's service, diesel engine starting, and control air systems.

Fire protection is via the fire pump supply to the fire main.

The vessel is fitted with trim tanks in the forward and the aft sections.

The following waste management system is fitted aboard the vessel in the Auxiliary Machinery Room (2-94-0-E):

(a) The system is of the vacuum collection type, with a vacuum collection tank, vacuum pumps, sewage holding tank (approximately 450 gallons capacity) and sewage overboard pumps all fitted along the vessel's centerline, Frames 96 to 107.

(b) Black water and gray water collect in separate mains and run that way to the sewage holding tank. Galley and turbid drains can also drain overboard instead of through the vacuum type valve required for collection in the holding tank.

(c) The sewage holding tank is discharged overboard and to weather deck hose connections to a pierside facility.

Special Remarks

The preliminary installation analysis of the candidate wastewater management systems was conducted with the assistance of various ship's drawings indicating the intended shipyard new construction of the "Pamlico". The findings written in that report reflect conditions depicted on those drawings. Normally, these findings are shipchecked using the actual subject vessel. In the case of the "Pamlico" this was not possible and in place of the ship, some of the "as built" drawings were furnished as a substitute. However, not all the drawings desired were available. Therefore, this report which determines the viablity of the systems is based on whatever information has been made available.

Some variations have been noted between the two issues of drawings, mainly in the arrangement of machinery in the Auxiliary Machinery Room. The "as built" arrangement appears to be more confining in the areas originally contemplated for modifications peculiar to each system studied. Therefore, some differences will be noted for certain system discussions between the two reports.

One of the more important unknowns remaining is the impact of considering the allocation of all or part of the Storage Space (2-79-0-A) just forward of the Auxiliary Machinery Room for some of the candidate wastewater management systems. In the absence of other guidance, it was assumed that the storage space was available for purposes of this study in accordance with the "Guidelines and Criteria for WMS Installation" contained in the "Installation Characteristics/Guidelines of Candidate Wastewater Management Systems for Selected Coast Guard Vessels" forming part of this overall study. The obvious consequence of non-availability would be to render many of the candidate systems non-viable and to modify others. This point is brought out since unquestionable locations and space are at a premium, being more or less limited to the Auxiliary Machinery Room where the existing wastewater management system is located.

VESSEL RESOURCES

Vessel: PAMLICO (WLIC – 800) - New Construction (160')

1. Fresh Water

a. Source of supply (i.e., storage tank, evaporator) STORAGE TANKS

b. Capacity (# of gals, etc.) 2-17-1-W = 6747 gals; 2-17-2W = 6747 gals; 2-34-1W = 3141 gal (cargo water); 2-34-2W = 3141 gals (cargo water); 2-49-1W = 3373 gals (cargo water); 2-49-2W-3373 gals (cargo water); 2-64-1W = 1690 gals (ship service); 2-64-2W = 1690 gals (ship service); 2-139-0W = 2381 gals.

c. Usage rate (# of gpd, etc.) First 3 days out: usage = 250 gpd } Includes fresh water flushing.
Remaining days: usage = 500 gpd }

2. Fuel Oil

a. Tank capacity (# of gals) 2-75-1F = 1014 gals; 2-75-2F = 1014 gals; 2-79-1F = 1690 gals; 2-79-2F = 1690 gals; 2-110-1F = 941 gals.

b. Usage rate (gpd, etc.) 600 gpd while transiting
300 gpd while on-station
During typical operations, 2/3 of the time ship is in transit and 1/3 of the time ship is on-station - thus average fuel usage = 500 gpd.

3. Electric Power

a. Capacity kw (2) Diesel 60 KW GENERATORS

b. Usage rate (when) NOT AVAILABLE

c. Maximum kw used NOT AVAILABLE

d. Average kwh per day NOT AVAILABLE

4. Compressed Air

a. Capacity (2) SHIPS SERVICE COMPRESSORS(each)160-120 psi; (2) STARTING AIR COMPRESSORS - Each 250 psi; (1) CONTROL AIR COMPRESSOR - 120-130 psi.

b. Usage rate NOT AVAILABLE

c. No. of hours compressors run per day or percentage of time NOT AVAILABLE

5. Capacity of Ventilation Air in CFM

a. Size of fan Supply-01-98-1 = 400 CFM; Exhaust 02-123-1 = 400 CFM; Exhaust 01-93-1 = 2800 CFM (HS.) 1400 CFM (LS); Supply 01-93-2 = 2800 CFM (HS) 1400 CFM (LS); Supply 01-121 = 750 CFM; Supply 01-121-1 = 5800 CFM (HS); 2900 CFM (LS); Exhaust - 01-121-2 = 750 CFM

6. DRAINAGE = ONE Holding Tank – 450 gals = Located in Forward Auxiliary Space
VESSEL uses Vacuum flushing system. PAMLICO is outfitted with Colt Industries Vacuum Collection Unit and with a 450 gallon vacuum coll. tank only (no CHT).
Gray water (and garbage grinder) are discharged into vacuum collection tank at pierside and overboard otherwise.

LOCATION OF BLACK WATER* WASTE SOURCES ABOARD A VESSEL

Vessel: PAMLICO (WLIC - 800) - New Construction (160')

Bulkhead Identification Frame #/To #	Level Identification	Compartment Location	Compartment Name	Number of Water Closets	Number of Urinals	Estimate of Number of People Served	Comments
105-111	01	CL	C.O. WR	1	0	1	
114-123	01	CL	P.O. WR	1	0	4	
111-123	1	CL/P	Crew's WR	2	1	10	

* Sewage (output from commodes and urinals) and garbage grinder slurry.

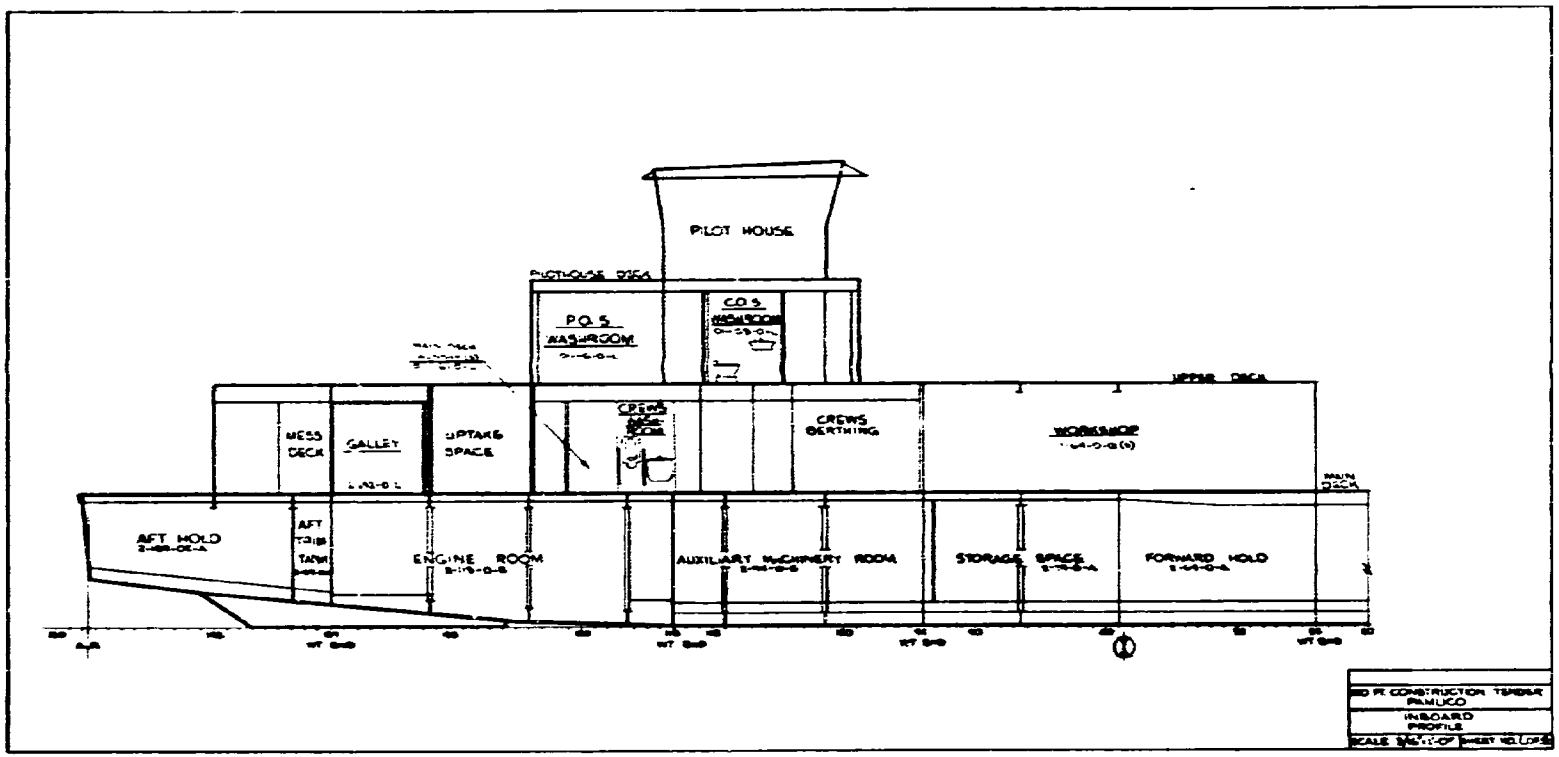
LOCATION OF GRAY WATER* WASTE SOURCES ABOARD A VESSEL

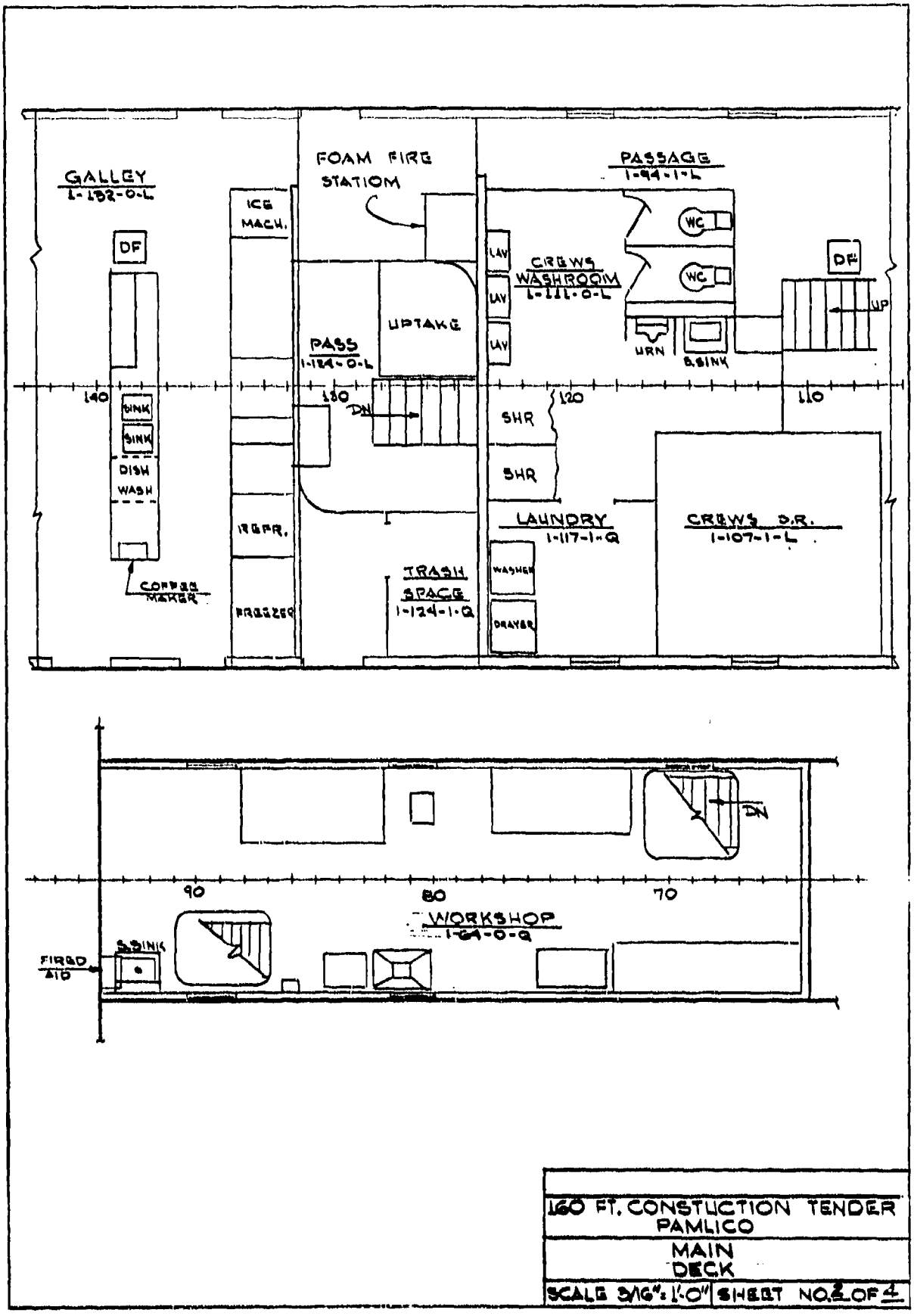
Vessel: PAMLICO (WLIC - 800) - New Construction (160')

Bulkhead Identification Frame #/To #	Level Identification	Compartment Location	Compartment Name	Waste Source	Comments
105-111	01	CL	C.O. WR	Shower (1)	
105-111	01	CL	C.O. WR	Lavatory (1)	
114-123	01	CL	P.O. WR	Shower (1)	
114-123	01	CL	P.O. WR	Lavatory (1)	
64- 94	1	S	Workshop	Slop Sink (1)	
111-123	1	P	Crew's WR	S. Sink (1)	
111-123	1	P	Crew's WR	Lavatories (3)	
111-123	1	S	Crew's WR	Showers (2)	
117-123	1	S	Laundry	Washing Machine (1)	
131-139	1	P	Galley	Drain from Ice Machine	
131-139	1	S	Galley	Drain from refrigerator	
131-139	1	S	Galley	Drain from freezer	
131-139	1	S	Galley	Sinks (2) (1) Sink Contains Garbage Grinder	
131-139	1	S	Galley	Dishwasher (1)	

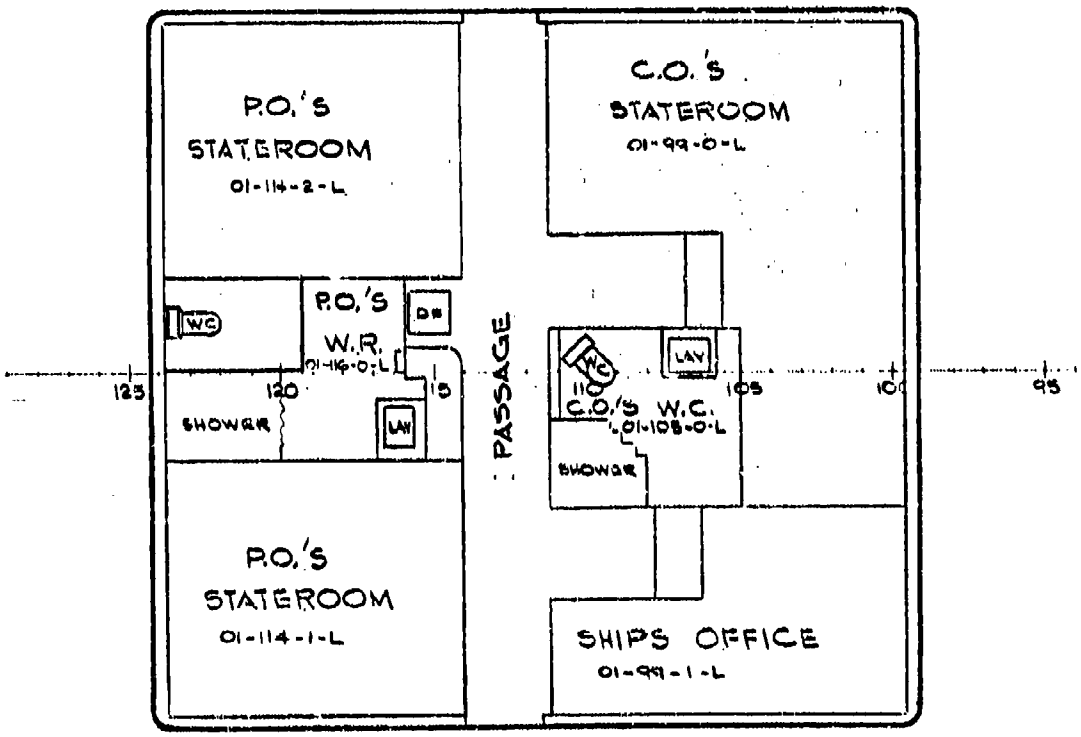
* Galley and turbid wastewater.

ARRANGEMENT OF BLACK AND GRAY WASTEWATER SOURCES

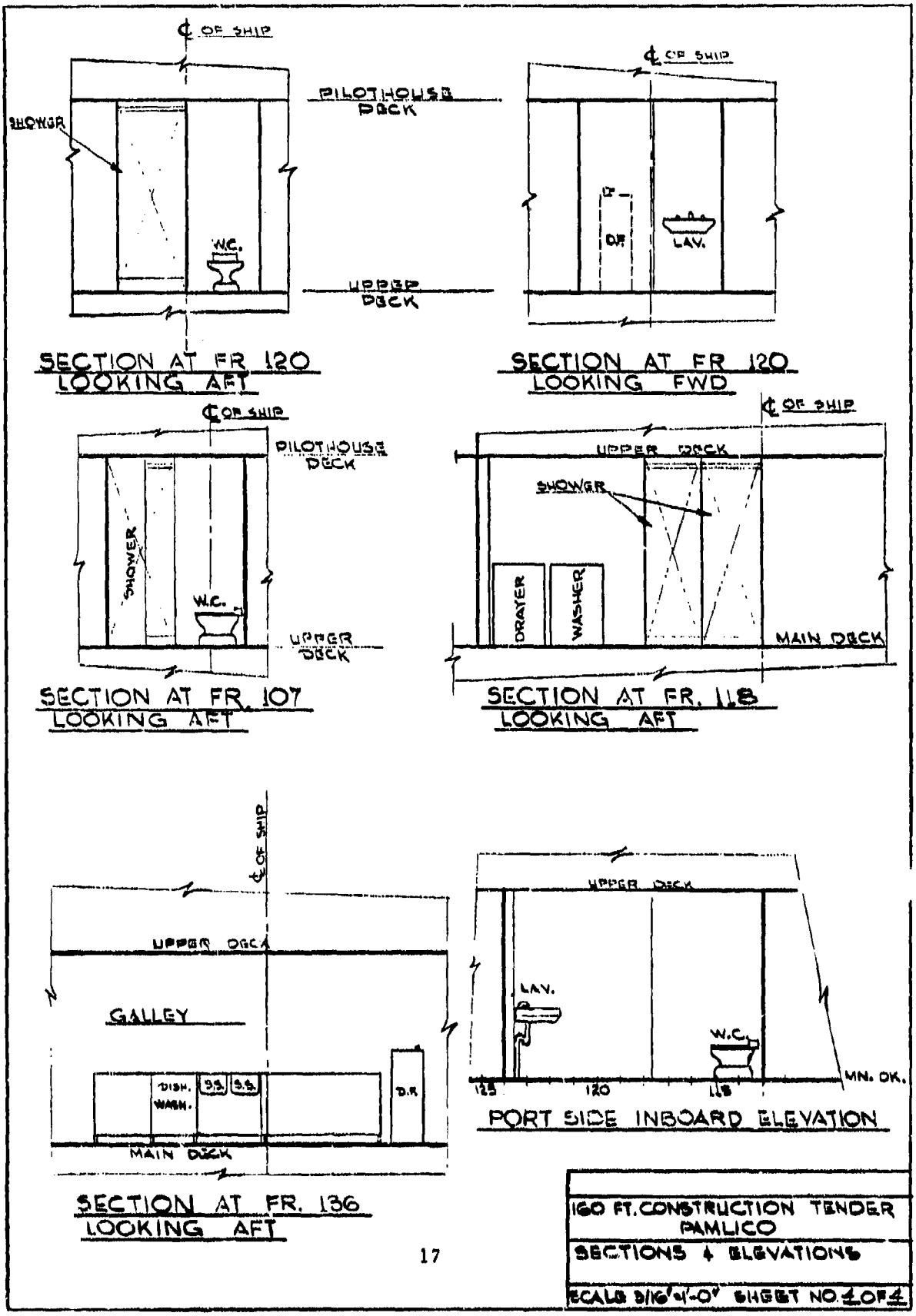




160 FT. CONSTUCTION TENDER PAMLICO
MAIN DECK
SCALE 3/16" = 1'-0" | SHEET NO. 2 OF 4



160 FT CONSTRUCTION TENDER PAMLICO	
UPPER DECK	
SCALE 3/16"=1'-0"	SHEET NO. 2 OF 4


℄ OF SHIP
PILOTHOUSE DECK
SHOWER
W.C.
UPPER DECK
SECTION AT FR 120 LOOKING AFT
℄ OF SHIP
DF
LAV.
SECTION AT FR 120 LOOKING FWD
℄ OF SHIP
PILOTHOUSE DECK
SHOWER
W.C.
UPPER DECK
SECTION AT FR. 107 LOOKING AFT
℄ OF SHIP
UPPER DECK
SHOWER
DRAYER
WASHER
MAIN DECK
SECTION AT FR. 118 LOOKING AFT
℄ OF SHIP
UPPER DECK
GALLEY
DISH. WASH.
S.S.
S.S.
D.R.
MAIN DECK
SECTION AT FR. 136 LOOKING AFT
UPPER DECK
LAV.
W.C.
MN. DK.
125
120
118
PORT SIDE INBOARD ELEVATION
160 FT. CONSTRUCTION TENDER
PAMLICO
SECTIONS & ELEVATIONS
SCALE 3/16"=1'-0" SHEET NO. 4 OF 4

WMS EQUIPMENT REQUIREMENTS

Vessel PAMLICO (160') (5) - New Construction

WMS Number	WMS Acceptability: Toilet Installed	WMS Acceptability: Toilet Present	WMS Acceptability: Holding Time (%): Black	WMS Acceptability: Holding Time (%): Gray	WMS Acceptability: Safety (Yes/No) (1)	Number of Fixtures: Commodes (2)	Number of Fixtures: Urinals (2)	JERED: Number of VCT's (Sized By Gallons): Small Boat: 30	60	Large Boat: 120	200	250	JERED: Number of Incinerators: Jered	Thiokol	GATX: Number of Pumps	GATX: Number of Evaporators (Sized By Gallons): 20	40	60	80	GRUMMAN: Number of Vapor Treatment Sections	Number of Treatment Subsystems	Number of Thiokol Incinerators	CHRYSLER: Collection and Recirc. Subsystem: Number of Separator Tanks: Model: A	A/B	B	CHRYSLER: Collection and Recirc. Subsystem: Number of P&FM Packages: Model: A	B	CHRYSLER: Incinerator Subsystem: Number of Sludge Surge Tanks: Model: B	C	CHRYSLER: Incinerator Subsystem: Number of Incinerators: Model: A	C	TANKS (4): BLACK (Gallons Each Tank)	TANKS (4): GRAY (Gallons Each Tank)
1	Yes	Yes	100	55	Yes	4S	1S																												3419B	5385B
2	Yes	Yes	100	64	Yes	4S	1S																	1				1							638C	6283B
3	Yes	Yes	100	64	Yes	4S	1S																	1				1				1				6283B
4	Yes	Yes	100	64	Yes	4S	1S																1												268A, 285C	6283B
5	Yes	Yes	100	100	Yes	4S	1S																1												268A, 1099C	
6	Yes	Yes	100	100	Yes	4S	1S																1												4233B	200A
7	Yes	Yes	100	64	Yes	4S	1S																1	1											68A	6283B
8	Yes	Yes	100	100	Yes	4S	1S																1	1											268A	
9	Yes	Yes	100	64	Yes	4J	1S/2J	1																											1070B	6283B
10	Yes	Yes	100	64	Yes	4J	1S/2J			1				1																						6283B
11	Yes	Yes	100	64	Yes	4J	1S/2J	1									1			1																6283B
12	Yes	Yes	100	100	Yes	4J	1S/2J	1															1												1070B	200A, 814C
13	Yes	Yes	100	100	Yes	4J	1S/2J	1															1	1												200A
14	Yes	Yes	100	64	Yes	4G	1S/1G									2																			1099B	6283B
15	Yes	Yes	100	64	Yes	4G	1S/1G								1	3																				6283B
16	Yes	Yes	100	64	Yes	4G	1S/1G									3		1			1															6283B
17	Yes	Yes	100	100	Yes	4G	1S/1G									3							1												1099B	200A, 814C
18	Yes	Yes	100	100	Yes	4G	1S/1G									3							1	1											26D	200A

WMS = Wastewater Management System
P&FM = Pressurization and Fluid Maintenance
(1) Does WMS meet all applicable safety standards?
(2) Letter following entered number means: S = Standard, J = JERED, G = GATX
(3) Letters following entered numbers mean: S = Standard urinal only, S/J = Standard urinals with indicated number of jered urinal discharge valves, S/G = Standard urinals with indicated number of GATX flushometers.
(4) Letter following entered gallonage denotes tank usage: A = Influent Surge, B = Wastewater holding, C = Sludge holding, D = Intermediate tank not supplied with MSD.
(5) Pamlico is currently outfitted with a Colt Industries 450-gallon VCT and no wastewater holding tank. Systems 9, 10, 11, 12 and 13 are configured with smaller VCT's and associated treatment/holding tank arrangements in accordance with the guidelines established for this study. It will be assumed, however, that these systems would be adequately served by the existing 450-gallon VCT plus appropriate treatment subsystems (i.e., incinerator/evaporator) with cost/effectiveness assessments treated accordingly.

WMS No.	1, 9, 12, 14, 17	2, 4	5, 6
Tank Height	6'-0"	4'-3"	5'0"

NOTES: (a) WMS No. 6 = Combined sewage/sludge holding tank.
(b) WMS No. 18 = Intermediate tank used as influent surge tank.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 1 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Sewage Holding Tank	3,419 gal. (457 cu.ft.)	See Discussion
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)	See Discussion
Sewage Holding Tank Discharge Pumps	Two (2)	
Galley/Turbid Holding Tank Discharge Pumps	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

A salt water sanitary flushing system would be required.

The components would be located as follows:

(a) The sewage holding tank would be in two sections, one section (approximately 8' L x 7' W x 6' H) in the Auxiliary Machinery Room in place of the existing sewage system equipment and the other section (approximately 8' L x 3' W x 6' H) in the Storage Space (2-79-0-A), starboard side, just forward of Auxiliary Machinery Room. Together the required holding capacity can be met.

(b) The required galley/turbid holding tankage cannot be fully met due to lack of available space. Therefore, a tank of approximately 5385 gallons (720 cu. ft.) can be located in the Storage Space just forward of the Auxiliary Machinery Room. The tank would be "L" shaped, taking up the complete port side and the space on the starboard side forward of the access ladder.

(c) The sewage holding tank discharge pumps would be located just aft of the tank in the Auxiliary Machinery Room.

(d) The galley/turbid holding tank discharge pumps would be located at the aft starboard end of the Storage Space.

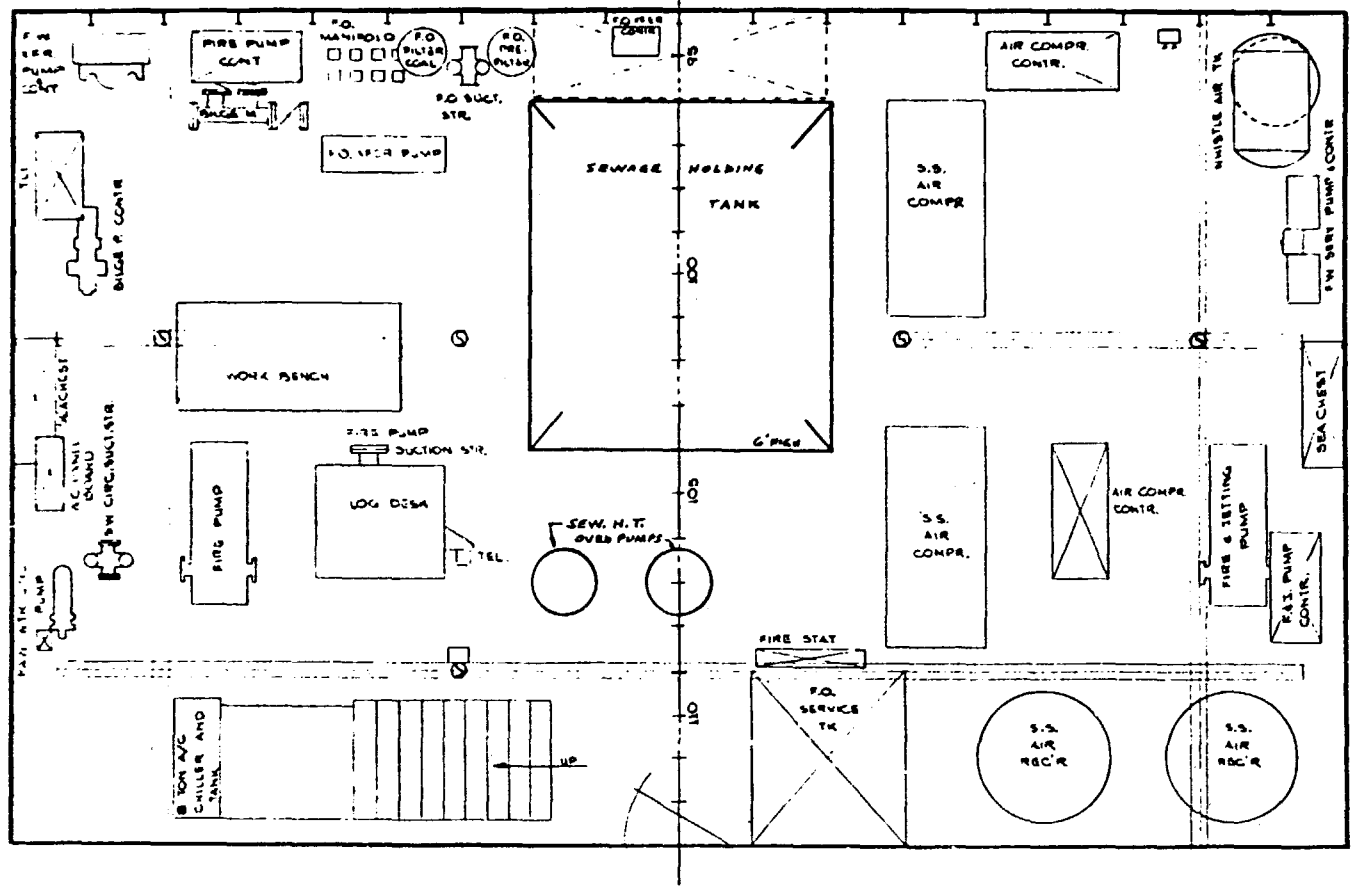
(e) The tankage arrangement in the Storage Space would eliminate its use for any other purposes.

Drainage would be as follows:

(a) Sewage would gravitate to the sewage holding tanks and would be pumped overboard or to pierside via the existing connections provided. Provision would have to be made to pump each section when filled to a pre-determined level.

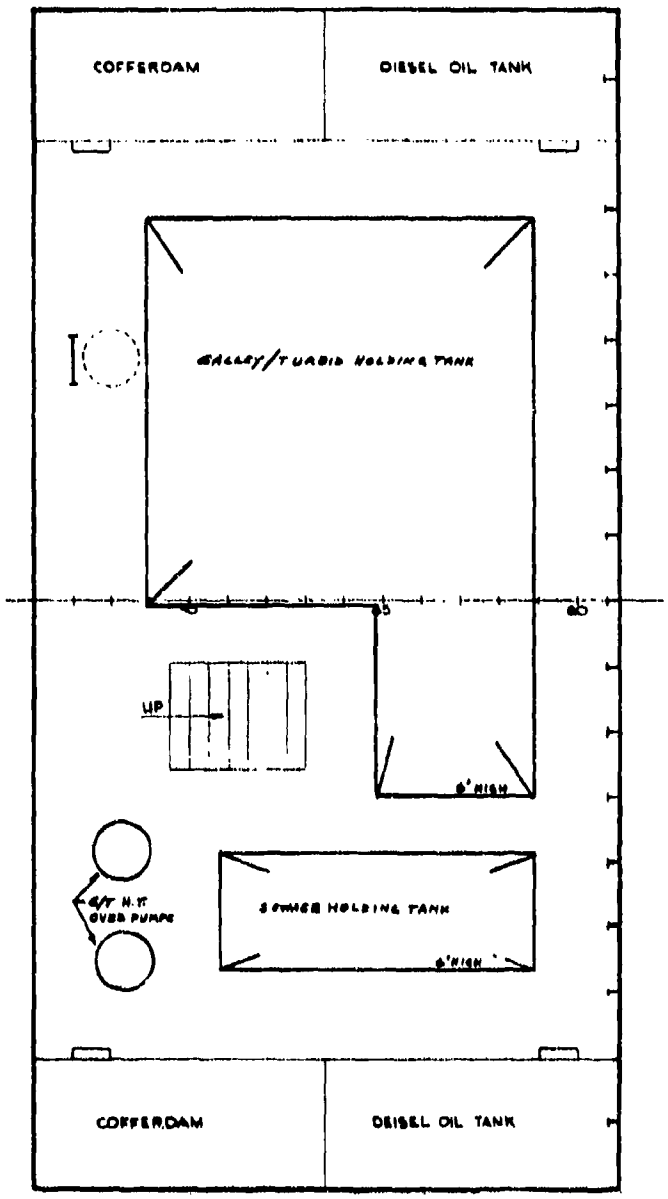
(b) Galley/turbid drains would gravitate overboard in unrestricted water and would gravitate to the G/T holding tank for retention and discharge overboard and pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM 2-94-0-E
SYSTEM NO. 1
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 2



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

USCG 11 CONSTRUCTION TENDER FAMILIES
STORAGE TANKS S-10-01A
SYSTEM NO. 1
SCALE 1/2"=1'-0" | SHEET NO. [illegible]

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 1

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,905[2]	8,573
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	13,465[4]	7,406
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	9,705[5]	8,929
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	310	620
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	160	960
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					28,518

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 2 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Sludge Holding Tank for Sewage/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Sewage Holding Tank	638 gal. (85 cu. ft.)	2'-6" x 8' x 4'-3"
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)	See Discussion
Chrysler Model and Quantity	One (1) Model A Separation Tank and One (1) Model A Pump and Fluid Maintenance Package	
Sewage Holding Tank Discharge Pumps	Two (2)	
Galley/Turbid Holding Tank Discharge Pumps	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Sewage holding tank in the Auxiliary Machinery Space, on the ship's centerline, in place of the existing sewage holding tank.

(b) Sewage tank discharge pumps (overboard and pierside) just aft of the tank.

(c) Chrysler separation tank and the pump and fluid maintenance package immediately aft of the sewage holding tank and its pumps, in place presently occupied by the sewage vacuum tank and the sewage pumps.

(d) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purposes.

(e) Galley/turbid holding tank discharge pump in aft starboard end of the Storage Space.

Drainage would be as follows:

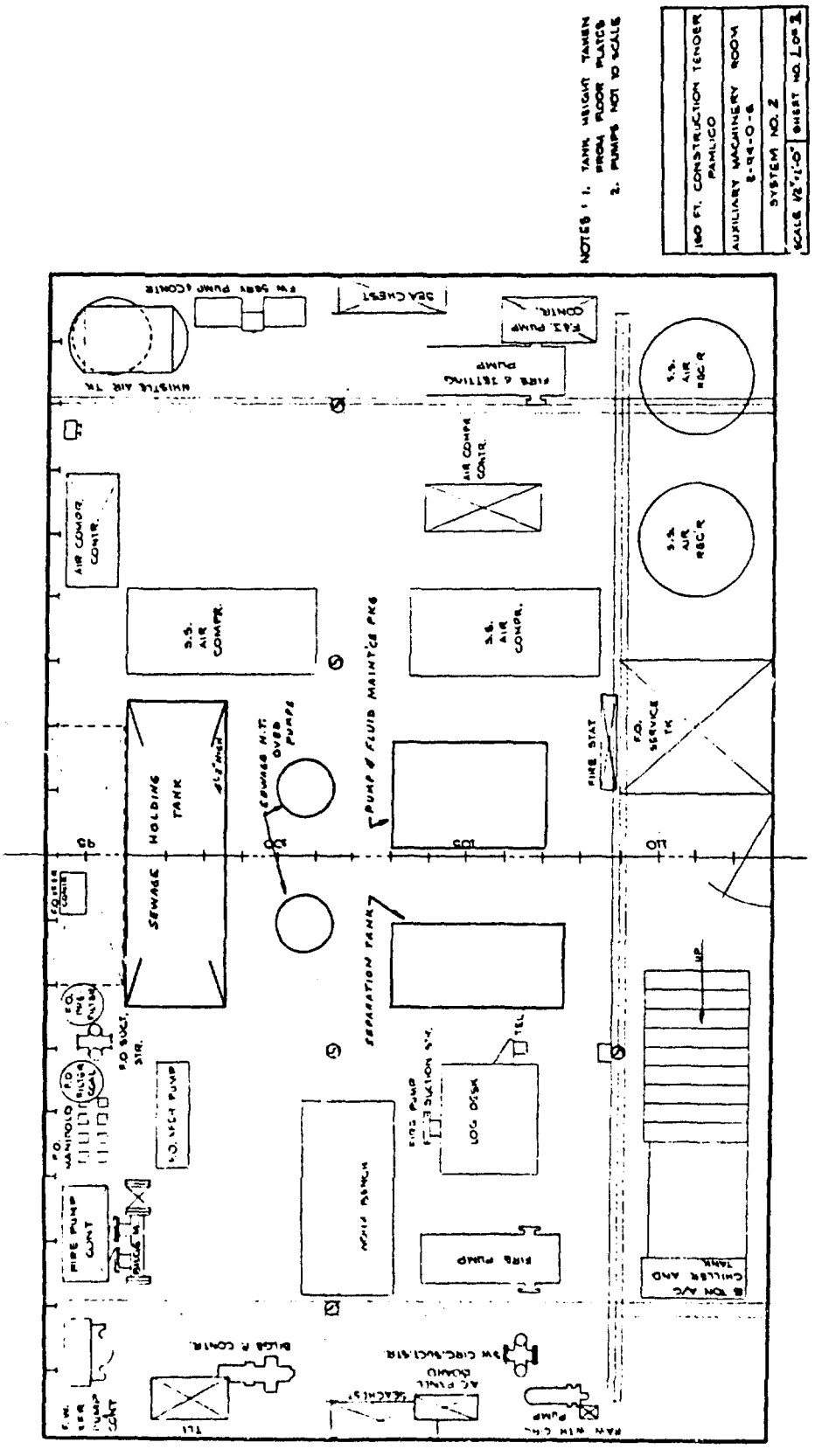
Garbage grinder drains would discharge directly to the sewage holding tank.

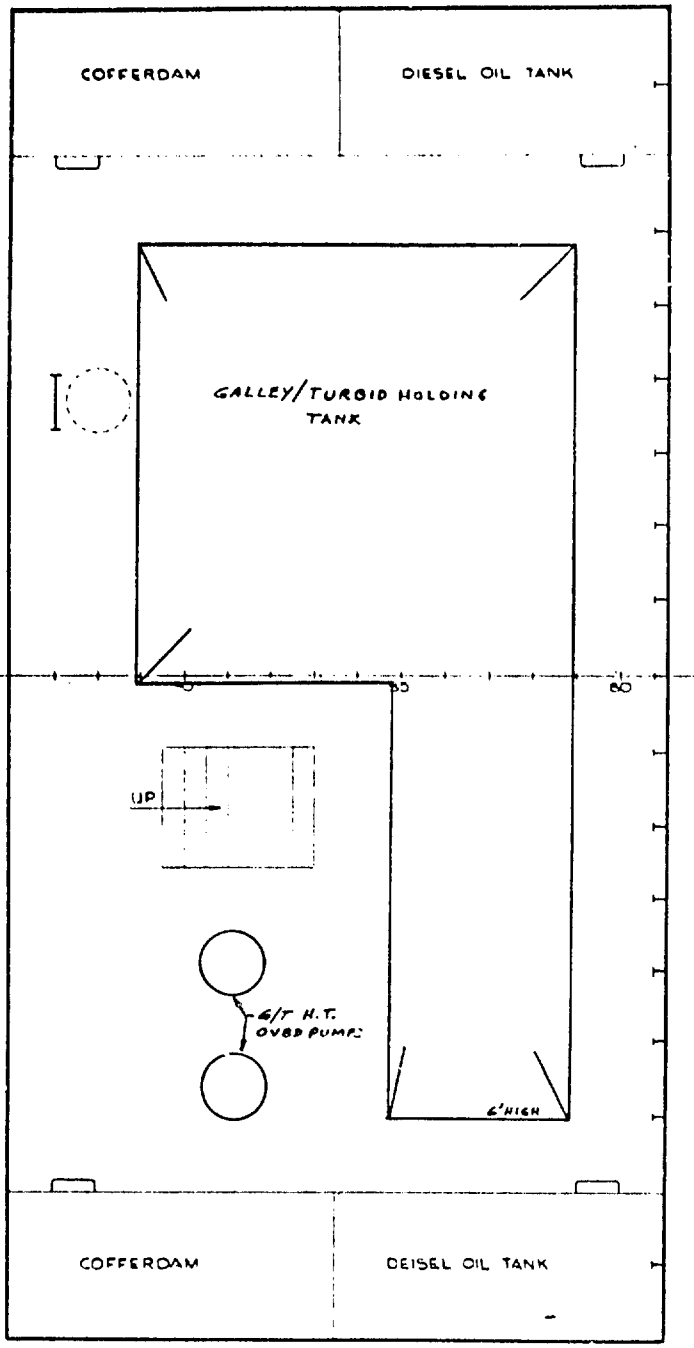
(a) Other sewage would gravitate to the Chrysler separation tank and the effluent pumped to the sewage holding tank.

(b) The sewage holding tank contents would be discharged overboard or to pierside according to prevailing restrictions.

(c) Galley/turbid drains would gravitate overboard in unrestricted waters and gravitate to the G/T holding tank for retention and discharge overboard/ pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT





NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-7'-0"A
SYSTEM NO. 2
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 2

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,185 [2]	9,833
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	9,705 [4]	5,338
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,055 [5]	6,491
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	375	750
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	140	840
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					25,282

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper suppor
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 3 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Incinerator for Sewage/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)	See Discussion
Sludge Ejection Tank	30 gal. (4 cu. ft.)	2' dia. x 1'-6" H
Chrysler Model and Quantity	One (1) Model A Separation Tank and One (1) Model A Pump and Fluid Maintenance Package	
Incinerator Model and Quantity	One (1) - A	
Sludge Ejection Tank Transfer Pump	One (1)	
Sludge Ejection Tank Discharge Pump	One (1)	
Galley/Turbid Holding Tank Discharge Pumps	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Chrysler separation tank and the pump and fluid maintenance package in the Auxiliary Machinery Space, forward end on ship's centerline in place of the existing sewage holding tank.

(b) Sludge ejection tank and its pumps just aft of the Chrysler separation tank, port side.

(c) Incinerator on starboard side just aft of Chrysler pump and fluid maintenance package. The stack would be run either aft to the Engine Room and up alongside the existing diesel exhausts to the weather or forward into the Storage Space and up into the weather on the Main Deck, starboard side, where the house front meets the workshop at Bhd 94. The latter appears to offer the simpler solution if there is no impediment to vessel's operations.

(d) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.) as in System No. 2. It would eliminate use of the space for any other purpose.

(e) Galley/turbid holding tank discharge pumps in aft starboard end of Storage Space.

(f) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

Drainage would be as follows:

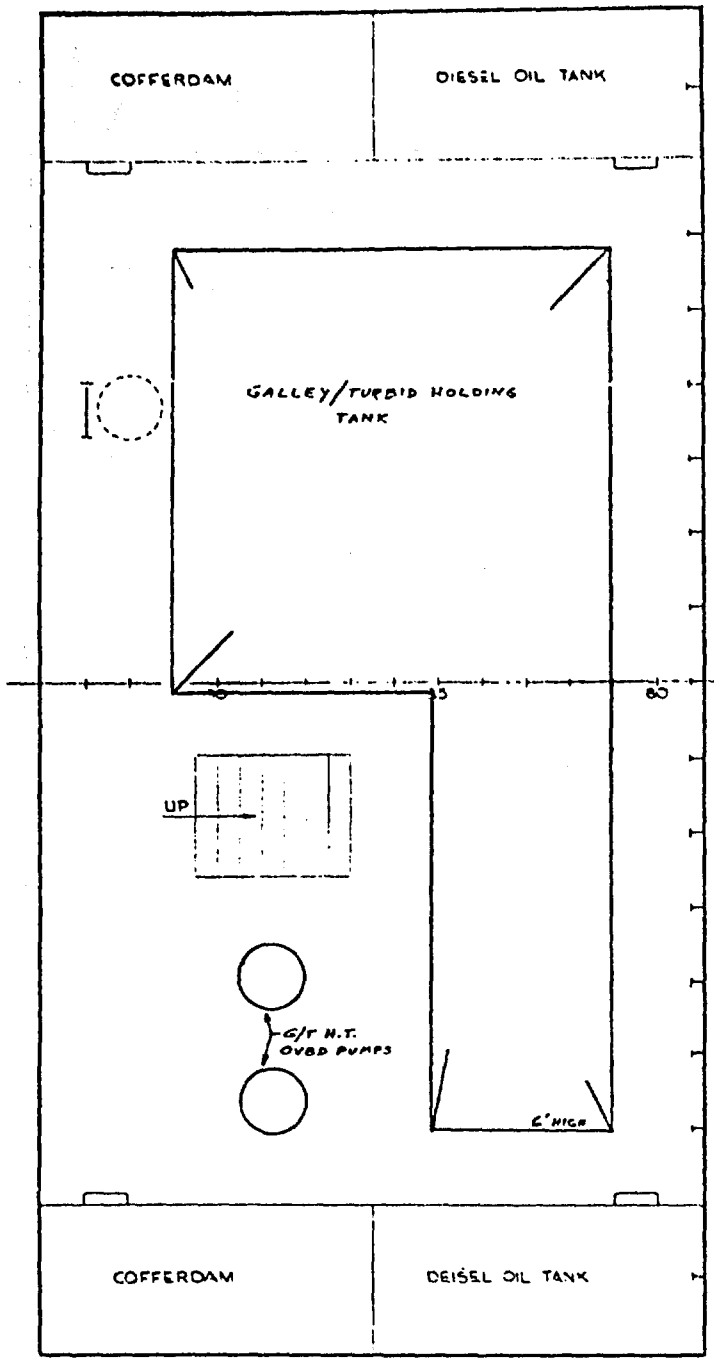
(a) Garbage grinder drains would discharge directly to the sludge ejection tank.

Other sewage would gravitate to the Chrysler separation tank and the effluent pumped to the sludge ejection tank.

(b) The ejection tank would discharge to the incinerator and to overboard/pierside according to prevailing restrictions.

(c) Galley/turbid drains would gravitate overboard in unrestricted waters and gravitate to the G/T holding tank for retention and discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES.
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 3
SCALE 1/8"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 3

Installation Cost Element	Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]	Pounds	$ 4.50/Lb. (Materials and Labor)	3,495 [2]	15,728
Tank Steel[3]	Pounds	$ .55/Lb. (Materials and Labor)	9,420 [4]	5,181
Foundations	Pounds	$ .92/Lb. (Materials and Labor)	6,585 [5]	6,059
Electric Cables	Feet	$ 2.00/Ft. (Materials and Labor)	375	750
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)	Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)	Feet	$ 1.00/Ft. (Labor)	55	55
Welding	Feet	$ 6.00/Ft. (Materials and Labor)	140	840
Removals: Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
Removals: Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)				30,588

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 4 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Black Water/ Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Sewage Influent Surge Tank	68 ga. (9 cu. ft.)	2' dia x 3' H
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)	See Discussion
Sludge Holding Tank	285 gal. (38 cu. ft.)	3' x 3' x 4'-3" H
Grumman Unit without Incinerator	One (1)	
Surge Tank Pump	One (1)	
Surge Tank Overboard Pump	Two (2)	
Sludge Transfer Pump	One (1)	
Galley/Turbid Holding Tank Discharge Pump	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

A salt water sanitary flushing system will be required.

The components would be located as follows:

(a) The Grumman unit in the Auxiliary Machinery Space in place of the existing Sewage Holding Tank.

(b) The sludge holding tank just aft of the Grumman unit, starboard side, in place of the existing sewage vacuum equipment.

(c) Sewage influent surge tank to port of the sludge holding tank in place of the existing sewage pumps.

(d) The pumps associated with the above components would be grouped functionally between them.

(e) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purpose.

(f) Galley/turbid holding tank discharge pumps in aft starboard end of Storage Space.

Drainage would be as follows:

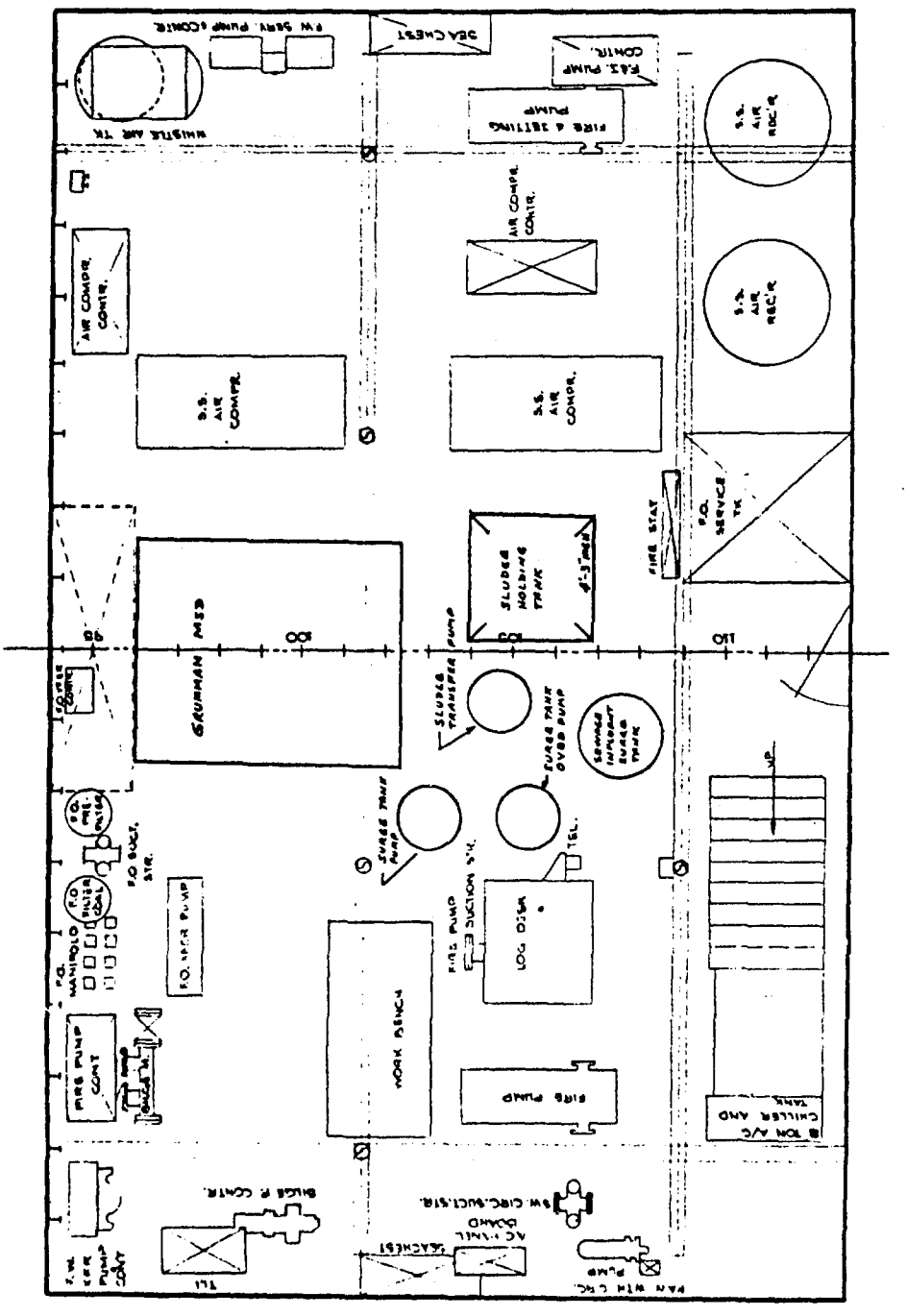
(a) Sewage would gravitate to the influent surge tank for transfer to the Grumman feed tank. The surge tank would be pumped overboard and to pierside according to prevailing restrictions.

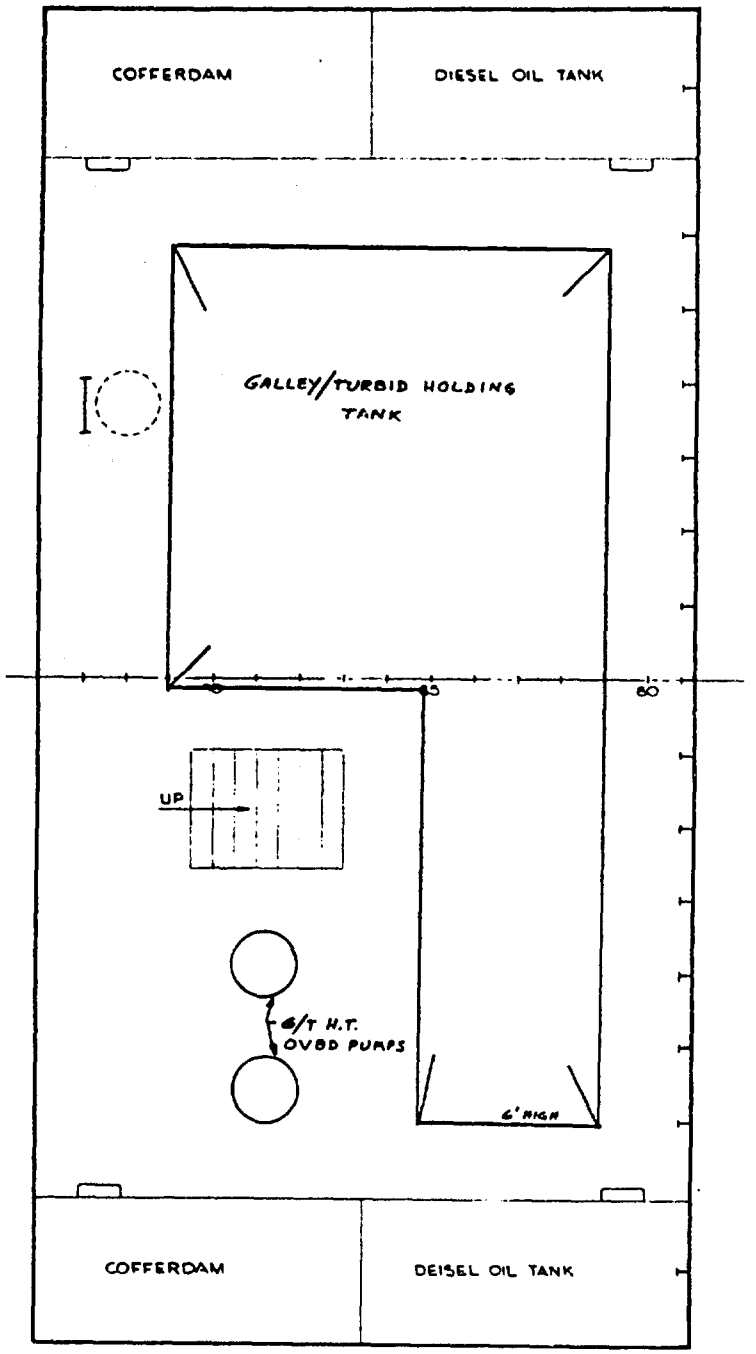
(b) The sludge holding tank would discharge to the influent surge tank for overboard/pierside discharge.

(c) The Grumman effluent tank would be discharged overboard.

(d) The Galley/turbid drains would gravitate overboard in unrestricted waters and gravitate to the G/T holding tank to be pumped overboard or to pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT





NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-77-0-A
SYSTEM NO. 4
SCALE 1/2"=1'-0" | SHEET NO 20F 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 4

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,970 [2]	8,865
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	9,770 [4]	5,374
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,910 [5]	6,358
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	440	880
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	115	690
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					24,272

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 5 **Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Combined Black and Gray Waters**

	Required	Approximate Dimensions (L x W x H)
Influent Surge Tank	268 gal. (36 cu. ft.)	3' dia x 5'-6" H
Sludge Holding Tank	1,099 gal. (147 cu. ft.)	5' x 6' x 5'
Grumman Unit without Incinerator	One (1)	
Surge Tank Pump	One (1)	
Surge Tank Overboard Pump	Two (2)	
Sludge Tank Transfer Pump	One (1)	

Discussion

The system is a viable candidate subject to certain conditions.

A salt water sanitary flushing system would be required.

Although similar to System No. 4, except for the elimination of the galley/turbid holding tank, the increased sizes of the remaining tanks requires a different arrangement. The components would best located as follows:

(a) The influent surge tank in the Auxiliary Machinery Space in place of the existing sewage holding tank.

(b) Grumman unit and sludge holding tank in the forward end (port and starboard) of Storage Space forward of the Auxiliary Machinery Room.

(c) Sludge holding tank transfer pump just aft of the tank.

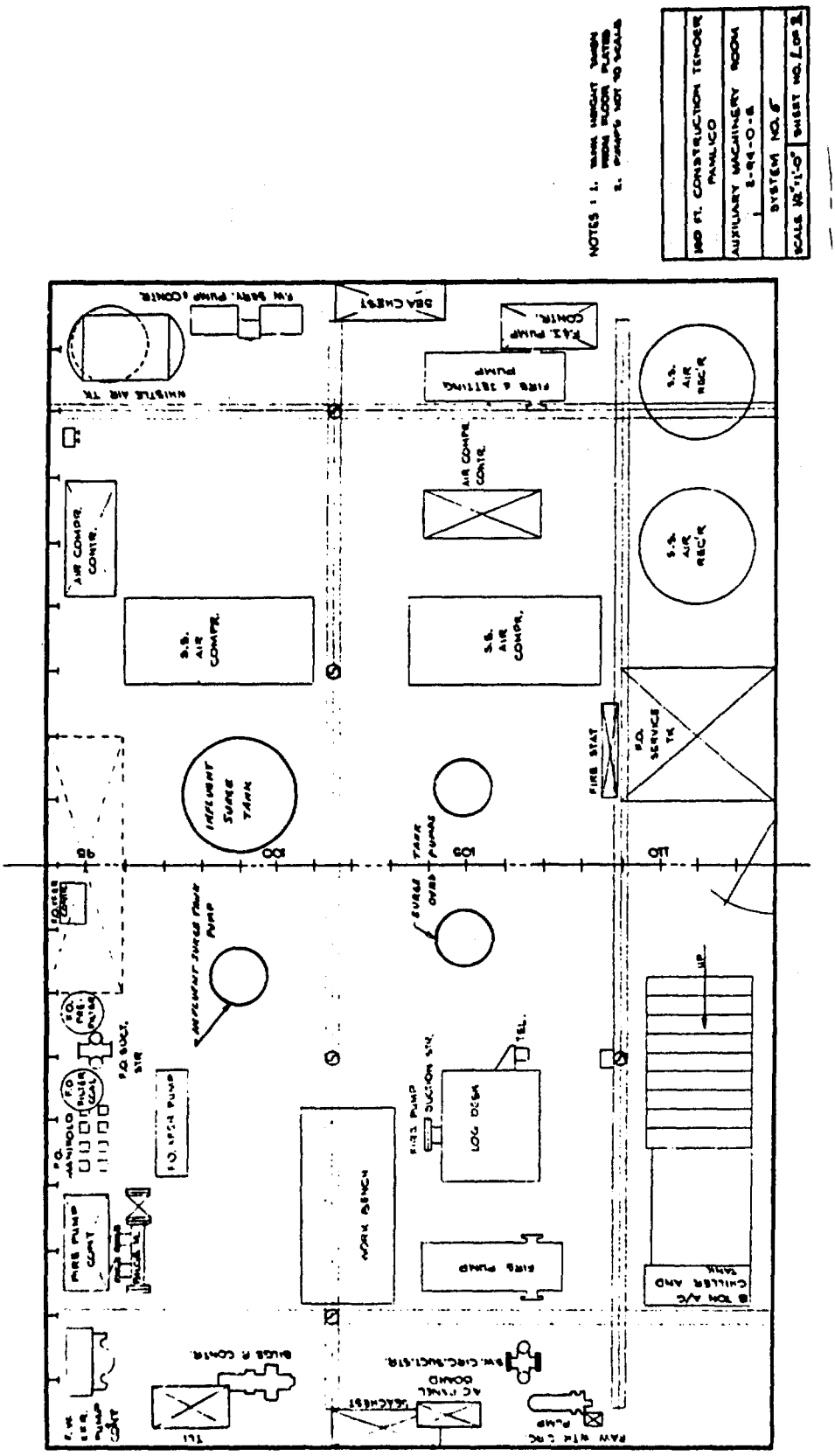
Drainage would be as follows:

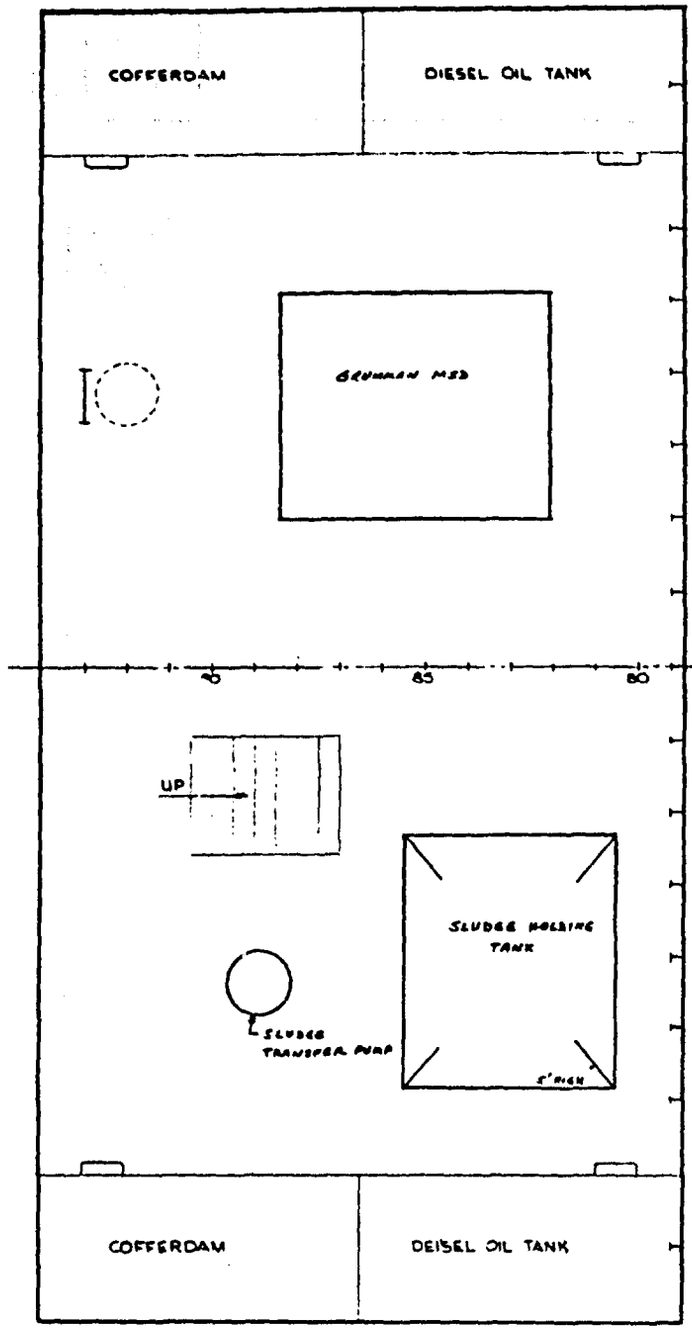
(a) All drains, sewage and galley/turbid, would gravitate to the influent surge tank for transfer to the Grumman feed tank. The surge tank would be pumped overboard and to pierside according to prevailing restrictions.

(b) The sludge holding tank would discharge to the influent surge tank for overboard/pierside discharge.

(c) The Grumman effluent tank would discharge overboard.

PROPOSED WMS EQUIPMENT ARRANGEMENT





NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 5
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PANULICO (160')

WMS No. 5

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,900 [2]	8,550
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	3,140 [4]	1,727
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	1,820 [5]	1,675
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	375	750
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	80	480
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					15,212

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 6 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
G/T Influent Surge Tank	200 gal. (27 cu. ft.)	3' dia x 4' H
Sewage Holding Tank	3,419 gal. (457 cu. ft.)	See Discussion
Sludge Holding Tank	814 gal. (109 cu. ft.)	See Discussion
Optional Combined Sewage/ Sludge Holding Tank	4,233 gal. (566 cu. ft.)	See Discussion
Grumman Unit without Incinerator	One (1)	
G/T Influent Surge Tank Pump	One (1)	
G/T Influent Surge Tank Transfer Pump	One (1)	
Sewage Holding Tank Overboard Pump	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

A salt water sanitary flushing system would be required.

The components would be located as follows:

(a) The Grumman unit in the Auxiliary Machinery Room in place of the existing sewage holding tank.

(b) The galley/turbid influent surge tank just aft of the Grumman unit.

(c) Surge tank pumps to starboard of the tank.

(d) For the optimum tank capacity arrangement, the optional combined sewage/sludge holding tank would be preferable and would be in the Storage Space forward of the Auxiliary Machinery Room. The tank would be "L" shaped, 5'-0" high for Grumman gravity drains, and extending port to starboard at the forward end of the space and then running aft along the starboard side. Neither the sewage holding nor the sludge holding tank by itself can be fitted in the Auxiliary Machinery Room. The Grumman unit cannot be fitted in the same compartment as the optional combined tank.

This arrangement would eliminate use of the space for any other purpose.

(e) The combined holding tank discharge pumps would be located just aft of the tank, starboard side.

Drainage would be as follows:

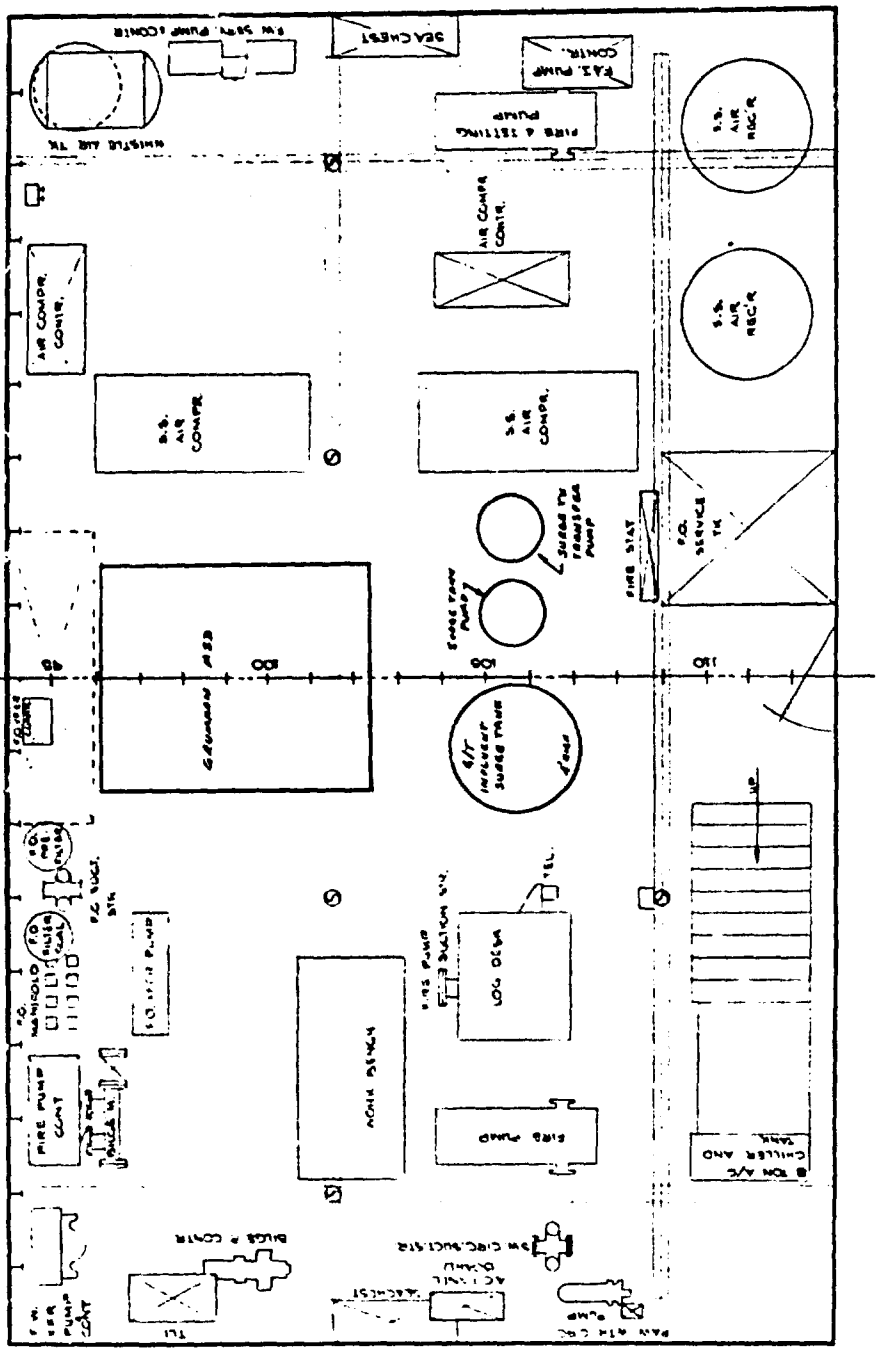
(a) Sewage would gravitate to the combined sewage/sludge holding tank for discharge overboard and to pierside.

(b) Galley/turbid drains gravitate overboard in unrestricted waters and to the influent surge tank in restricted waters for transfer to the Grumman feed tank.

(c) The influent surge tank would be pumped to the combined sewage/sludge holding tank for off-loading pierside.

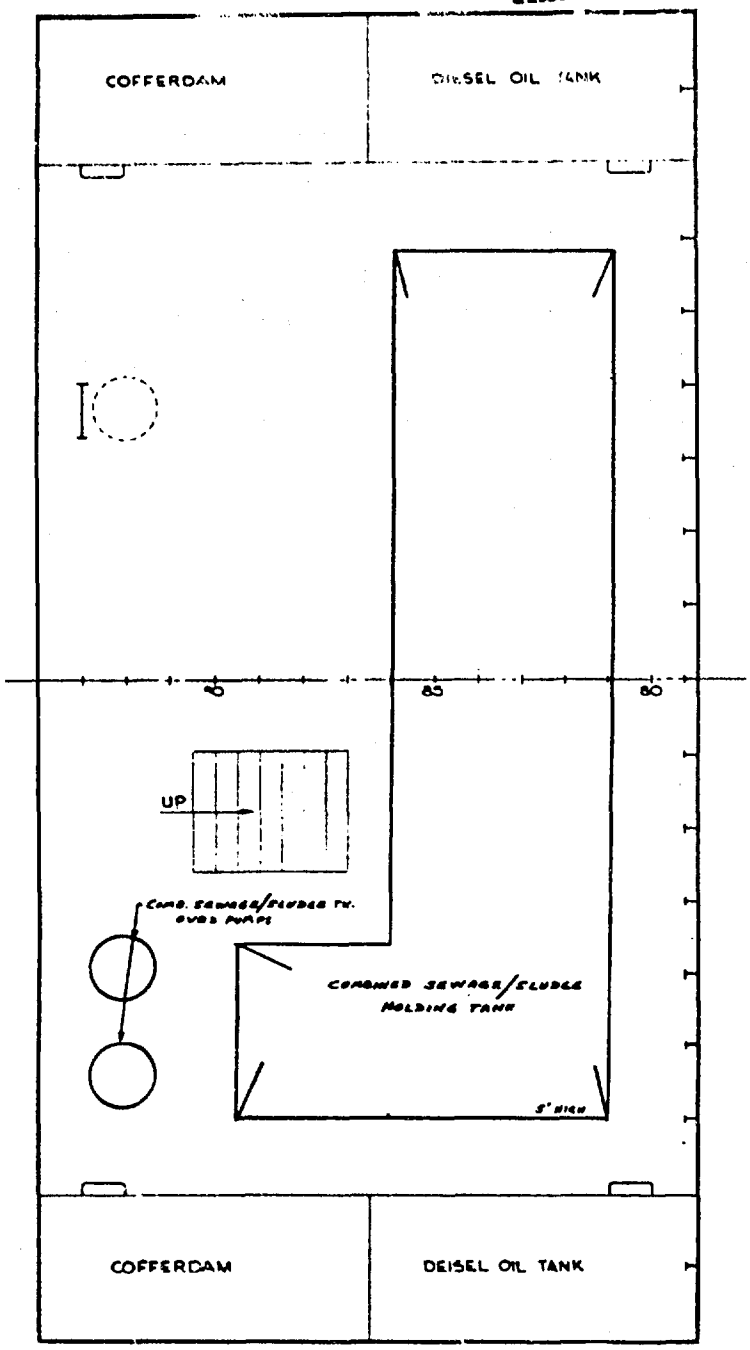
(d) The Grumman effluent tank would discharge overboard.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

KD FT. CONSTRUCTION TENDER FOR MILITARY	
AUXILIARY MACHINERY ROOM	
E-94-0-6	
SYSTEM NO. 6	
SCALE 1/2"=1'-0"	SHEET NO. 1 OF 2



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PANLICO
STORAGE SPACE 2-79-0-M
SYSTEM NO. 8
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 6

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,230 [2]	10,035
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	6,180 [4]	3,399
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	4,700 [5]	4,324
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	375	750
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	110	660
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					21,198

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 7 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)	See Discussion
Sewage Influent Surge Tank	68 gal. (9 cu. ft.)	2' dia x 3' H
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)	1'-6" x 1'-6" x 1'-6"
Grumman Unit with Incinerator	One (1) with One (1) Thiokol Incinerator	
Influent Surge Tank Pump	One (1)	
Influent Surge Tank Overboard Pump	Two (2)	
Galley/Turbid Holding Tank Overboard Pump	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

A salt water sanitary flushing system would be required.

The system is similar to System No. 4 except that there is an incinerator in lieu of a sludge holding tank.

The components would be located as follows:

(a) The Grumman unit with incinerator in the Auxiliary Machinery Space in place of the existing Sewage Holding Tank. The incinerator stack would run as described under System No. 3.

(b) The sewage influent surge tank just aft of the Grumman unit, starboard side, in place of the existing sewage vacuum equipment.

(c) Sewage influent surge tank pumps to port of the surge tank in place of the existing sewage pumps.

(d) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). This would eliminate use of the space for any other purpose.

(e) Galley/turbid holding tank discharge pumps in aft starboard end of Storage Space.

(f) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

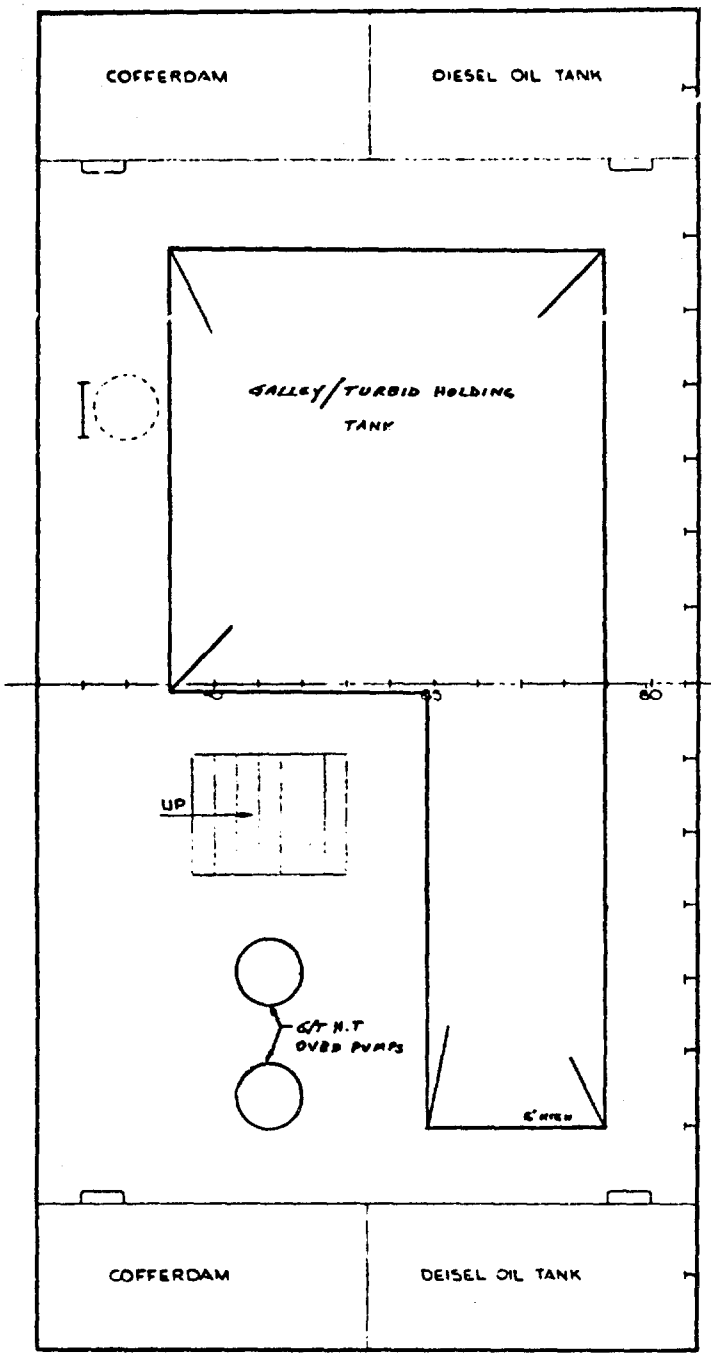
Drainage would be as follows:

(a) Sewage would gravitate to the influent surge tank for transfer to the Grumman feed tank. The surge tank would be pumped overboard and to pierside according to prevailing restrictions.

(b) The Grumman effluent tank would be discharged overboard.

(c) The Galley/turbid drains would gravitate overboard in unrestricted waters and gravitate to the G/T holding tank to be pumped overboard or to pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 7
SCALE 1/2"=1'-0" | SHEET NO 20 OF 2

WMS INSTALIATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 7

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb (Materials and Labor)	3,205 [2]	14,423
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	9,035 [4]	4,970
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,755 [5]	6,215
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	440	880
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	105	630
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					29,223

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 8 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Combined Black and Gray Waters

	Required	Approximate Dimensions (L x W x H)
Influent Surge Tank	268 gal. (36 cu. ft.)	2' x 3' x 6'
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)	1'-6" x 1'-6" x 1'-6"
Grumman Units with Incinerators	One (1) with One (1) Thiokol Incinerator	
Influent Surge Tank Pump	One (1)	
Influent Surge Tank Overboard Pumps	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

A salt water sanitary flushing system would be required.

The system is similar to System No. 7 except that there is no galley/turbid holding tank.

The components would be located as follows:

(a) The Grumman unit with incinerator in the Auxiliary Machinery Space in place of the existing Sewage Holding Tank. The incinerator stack would run as indicated for System No. 3.

(b) The sewage influent surge tank just aft of the Grumman unit, starboard side, in place of the existing sewage vacuum equipment.

(c) Sewage influent surge tank overboard pumps to port of the surge tank in place of the existing sewage pumps and the surge tank transfer pump forward of the tank.

(d) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

Vessel: PAMLICO (160')

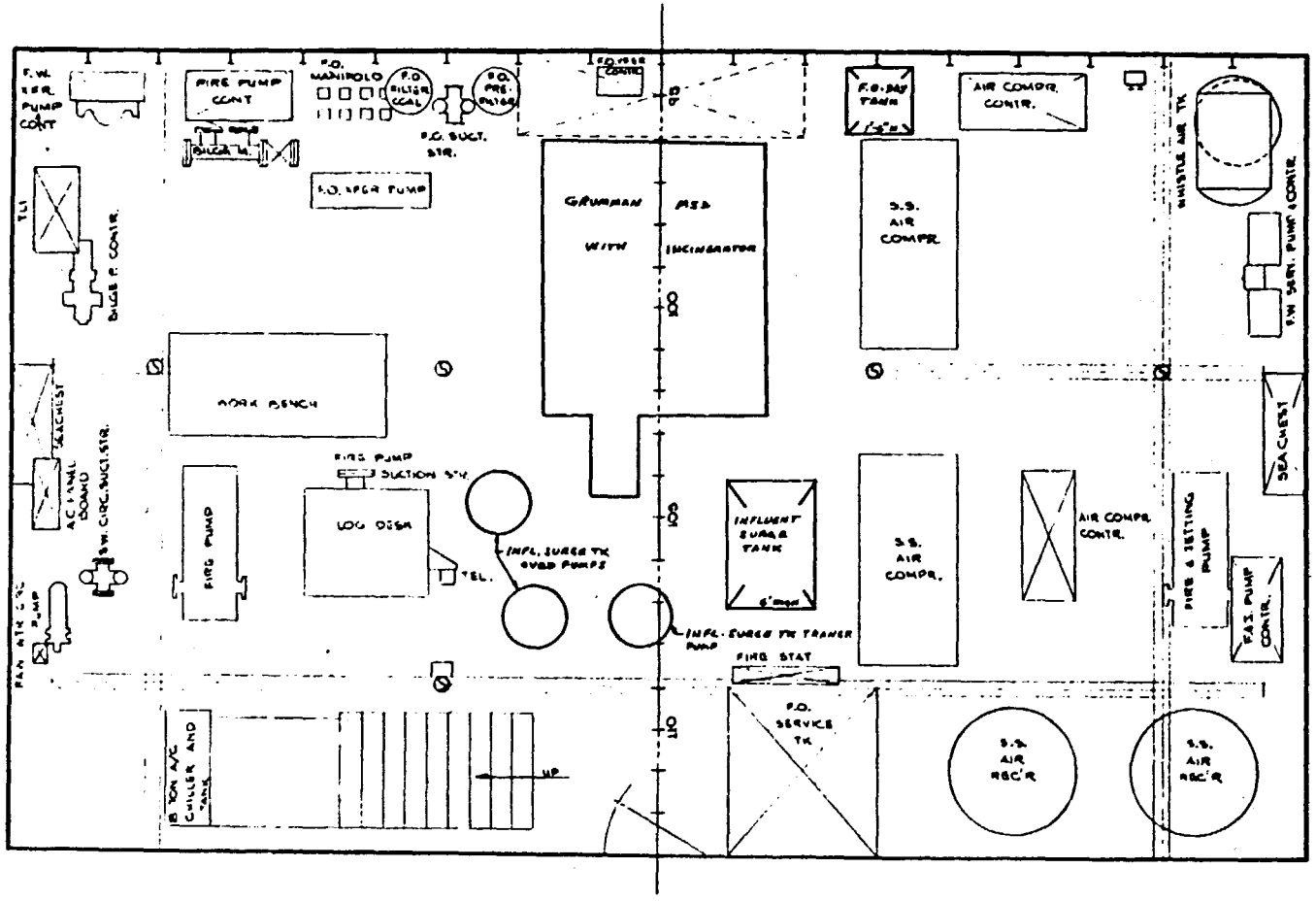
System No. 8 (Cont'd)

Drainage would be as follows:

(a) Sewage and Galley/Turbid drains would gravitate to the influent surge tank for transfer to the Grumman feed tank. The surge tank would be pumped overboard and to pierside according to prevailing restrictions.

(b) The Grumman effluent tank would be discharge overboard.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM E-94-0-A
SYSTEM NO. 8
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 1

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 8

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	3,100 [2]	13,950
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	1,145 [4]	630
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	840 [5]	773
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	260	520
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	25	375
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	30	30
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	50	300
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					18,028

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 9 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Vacuum Collection Tank	30 gal. (4.4 cu. ft.)	16" dia. x 38" H
Sewage Holding Tank	1,070 gal. (143 cu. ft.)	5' x 5' x 6'
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)	See Discussion
Sewage Holding Tank Overboard Pumps	Two (2)	
Galley/Turbid Holding Tank Overboard Pumps	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

The system is similar to that already existing, except that a galley/turbid holding tank is being included.

The components would be located as follows:

(a) Sewage holding tank vacuum collection tank and sewage overboard pumps in the Auxiliary Machinery Room in place of the existing equipment for the same functions.

(b) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purposes.

(c) Galley/turbid holding tank discharge pumps in aft starboard end of the Storage Space.

Vessel: PAMLICO (160')

System No. 9 (Cont'd)

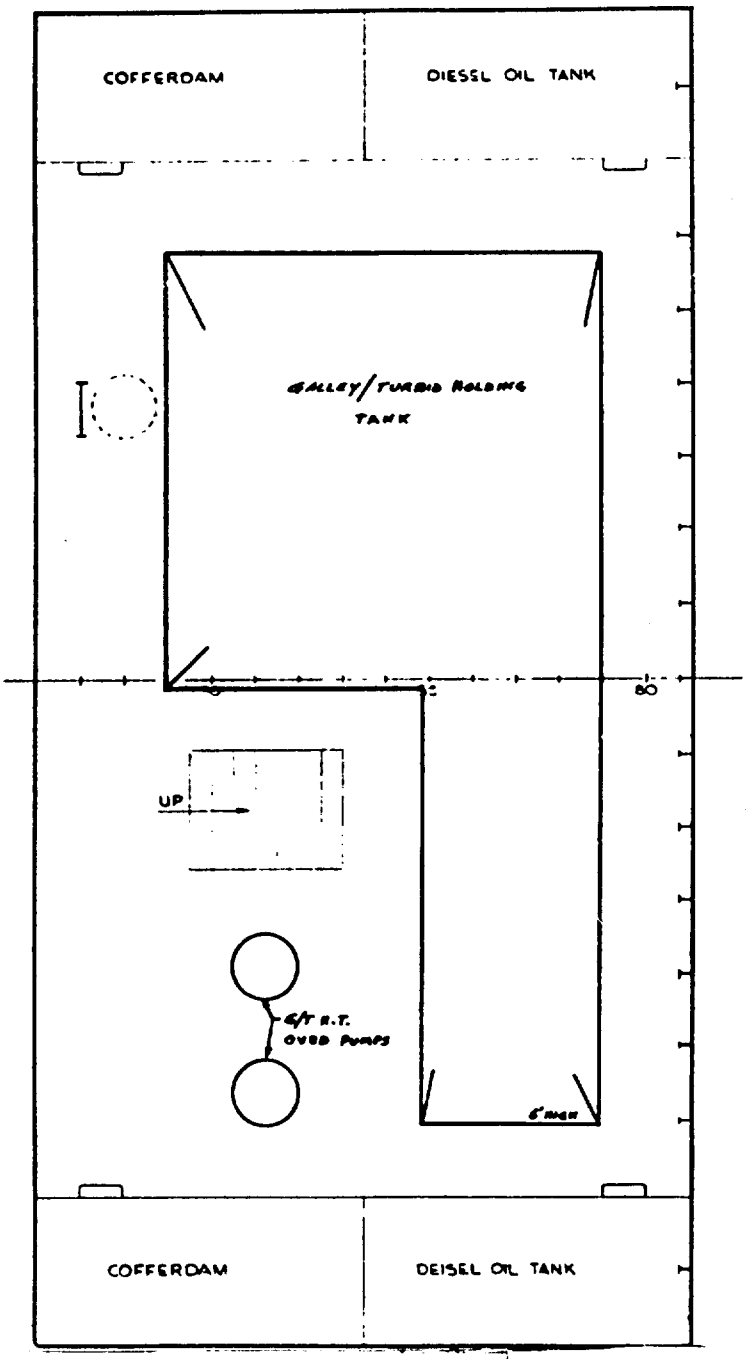
Drainage would be as follows:

(a) Sewage would be collected in the vacuum collection tank for transfer to the sanitary holding tank.

(b) The sanitary holding tank would be pumped overboard or to pierside according to prevailing restrictions.

(c) Galley/turbid drains would gravitate overboard in unrestricted waters and to the G/T holding tank for discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PANLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 9
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 9

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	825[2]	3,713
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	10,775[4]	5,927
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,355[5]	6,767
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	310	620
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	125	750
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					19,882

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 10 JERED Reduced Volume Flush Vacuum Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Vacuum Collection Tank	120 gal. (18 cu. ft.)	20" dia. x 4' H
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)	See Discussion
Incinerator Feed Tank (Sludge)	50 gal. (6.5 cu. ft.)	2'-6" x 1'x 2'-7"
Fuel Oil Day Tank	28 gal. (3.8 cu. ft.)	1'-9" x 1'-9" x 1'-9"
Incinerator	One (1) Thiokol	
Vacuum Collection Tank Overboard Pump	One (1)	
G/T Holding Tank Overboard Pump	Two (2)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Vacuum collection tank and pump in the Auxiliary Machinery Room in place of the existing sewage holding tank.

(b) Incinerator, its blower and feed tank aft of the vacuum collection tank. The incinerator stack would run as indicated in System No. 3.

(c) VCT and G/T overboard discharge pumps to port of the vacuum collection tank and incinerator.

(d) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purposes.

(e) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

Drainage would be as follows:

(a) Sewage would be collected in the vacuum collection tank for transferral to the incinerator feed tank.

(b) The vacuum collection tank would be pumped overboard and to pierside according to prevailing restrictions.

(c) Galley/turbid drains would gravitate overboard in unrestricted waters and to the galley/turbid holding tank for discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT

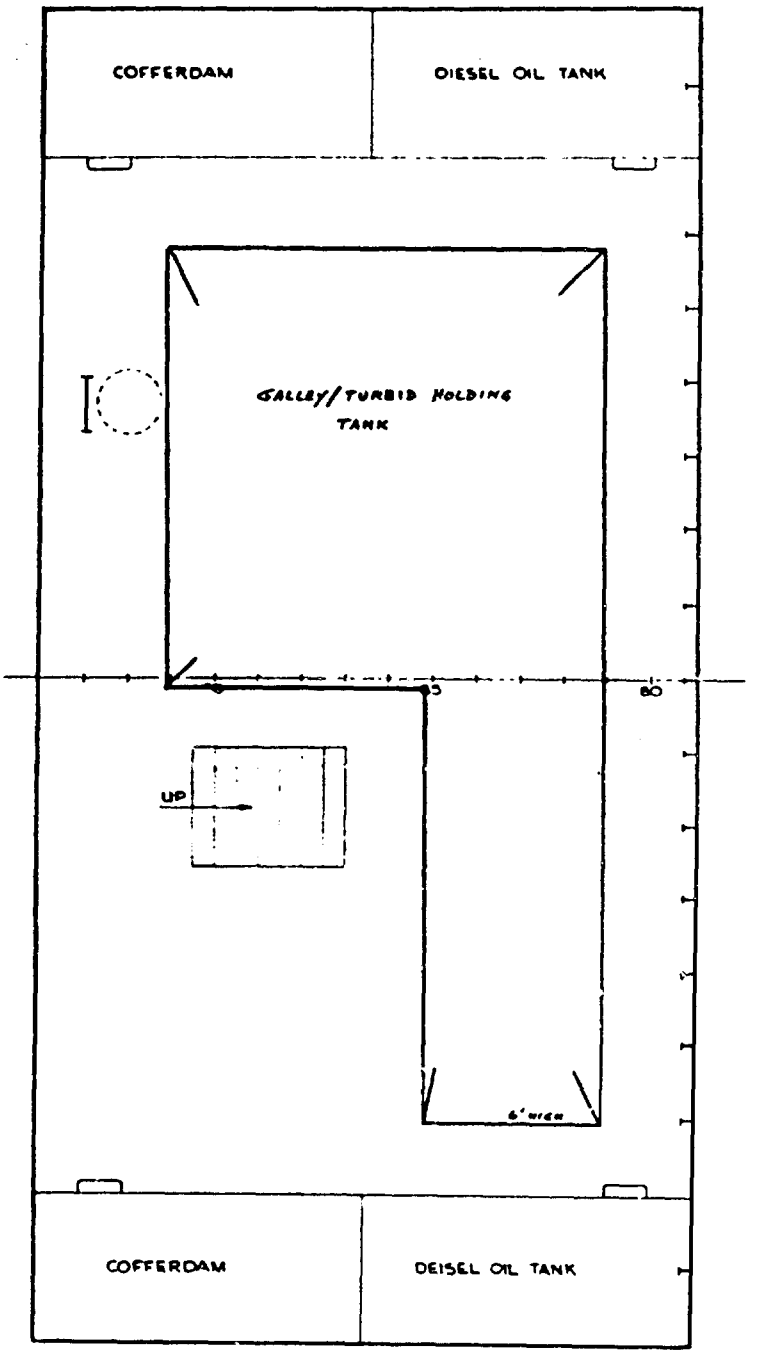
NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER
PANLICO

AUXILIARY MACHINERY ROOM
E-94-0-6

SYSTEM NO. 10

SCALE 1/2"=1'-0" | SHEET NO. 1 of 2



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 10
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 10

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,705 [2]	7,673
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,755 [4]	4,816
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,455 [5]	5,939
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	260	520
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	65	390
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					21,368

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 11 JERED Reduced Volume Flush Vacuum Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Vacuum Collection Tank	30 gal. (4.4 cu. ft.)	16" dia. x 38" L
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)	See Discussion
Evaporator (GATX)	One (1)-40 gal.	
Catalytic Oxidizer	One (1)	
Galley/Turbid Holding Tank Overboard Pumps	Two (2)	
Evaporator Overboard Pump	One (1)	

Discussion

The system is a viable candidate subject to certain considerations.

The system is similar to System No. 10 except that there is an evaporator in lieu of an incinerator.

The components would be located as follows:

(a) Vacuum collection tank and vacuum pump in the Auxiliary Machinery Room in place of the existing vacuum equipment.

(b) Evaporator and its overboard pump forward of the VCT.

(c) G/T overboard discharge pumps to port of the vacuum collection tank.

(d) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purposes.

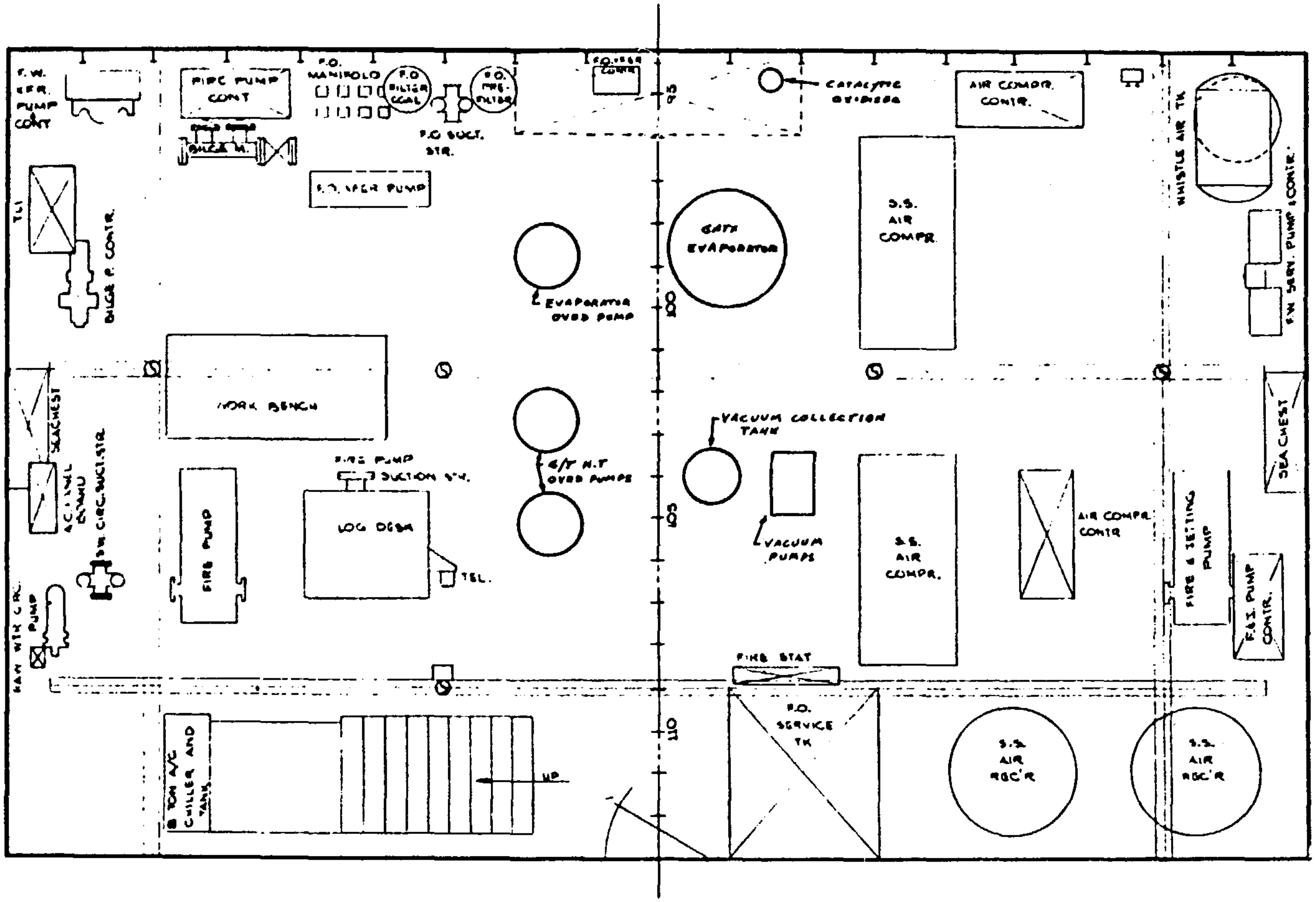
Drainage would be as follows:

(a) Sewage would be collected in the vacuum collection tank for transferral to the evaporator.

(b) The vacuum collection tank would be pumped overboard and to pierside according to prevailing restrictions.

(c) Galley/turbid drains would gravitate overboard in unrestricted waters and to the galley/turbid holding tank for discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM 8-94-0-6
SYSTEM NO. 11
SCALE 1/2"=1'-0" SHEET NO. 1 OF 3

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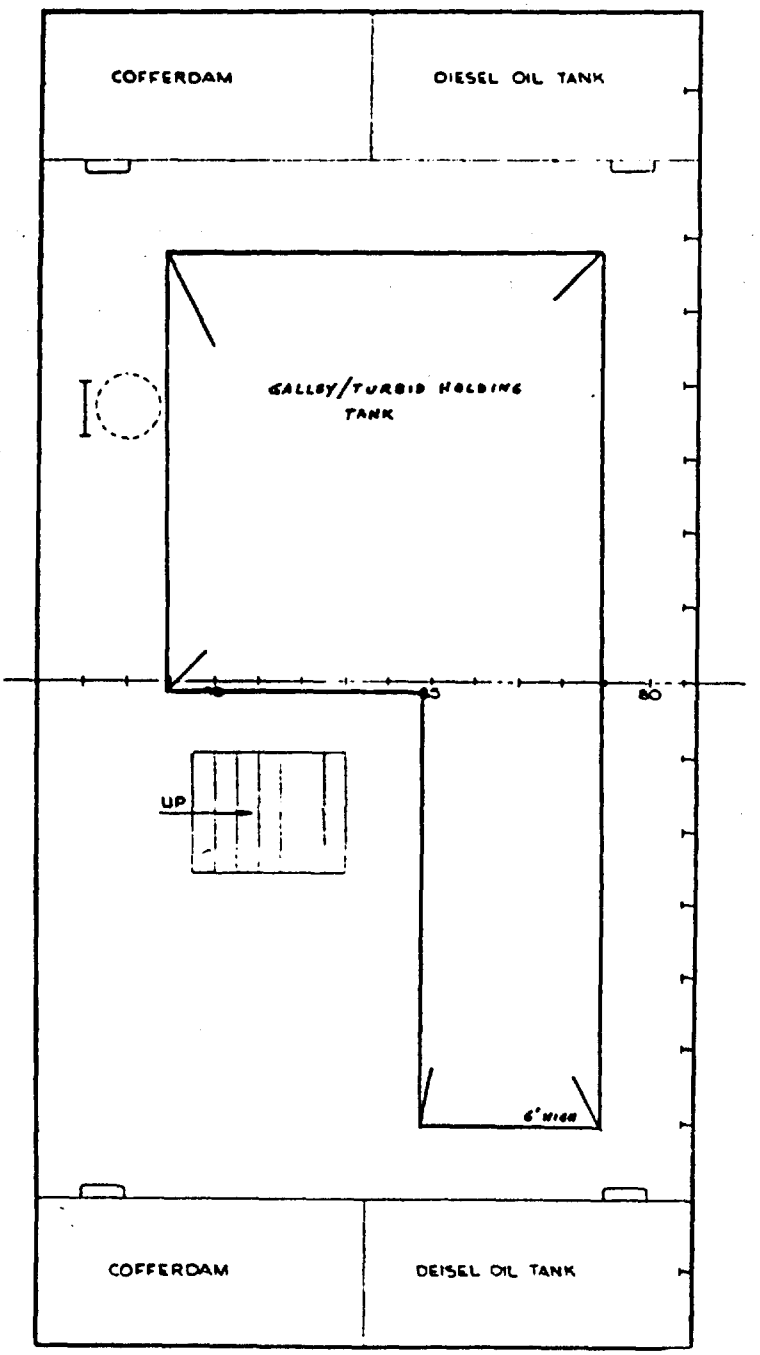


NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 8-79-0-A
SYSTEM NO. 11
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 11

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	510[2]	2,295
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,515[4]	4,684
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,285[5]	5,783
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	260	520
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	25	375
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	110	660
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					15,822

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 12 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Galley/Turbid Influent Surge Tank	200 gal. (27 cu. ft.)	3' dia. x 4' H
Sludge Holding Tank	814 gal. (109 cu. ft.)	5' x 5' x 4'-6"
Sewage Vacuum Collection Tank	30 gal. (4.4 cu. ft.)	16" dia. x 38" L
Sewage Holding Tank	1,070 gal. (143 cu. ft.)	5' x 5' x 6'
Grumman Unit without Incinerator	One (1)	
Sewage Holding Tank Overboard Pumps	Two (2)	
Sludge Holding Tank Transfer Pump	One (1)	
Influent Surge Tank Transfer Pump	One (1)	
Influent Surge Tank Pump	One (1)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) The sewage holding tank in the Auxiliary Machinery Room in place of the existing sewage holding tank.

(b) Sewage holding tank overboard pumps to port of the tank.

(c) The galley/turbid influent surge tank just aft of the sewage holding tank.

(d) Surge tank pumps forward of the tank.

(e) Vacuum collection tank and pumps in place of the existing sewage vacuum equipment.

(f) Grumman unit and sludge holding tank at the forward end of the Storage Space just forward of the Auxiliary Machinery Room.

(g) Sludge holding tank transfer pump just aft of the tank on starboard side of the space.

Drainage would be as follows:

(a) Sewage would be collected in the vacuum collection tank for discharge to the sewage holding tank.

(b) The sewage holding tank is pumped overboard/pierside according to prevailing restrictions.

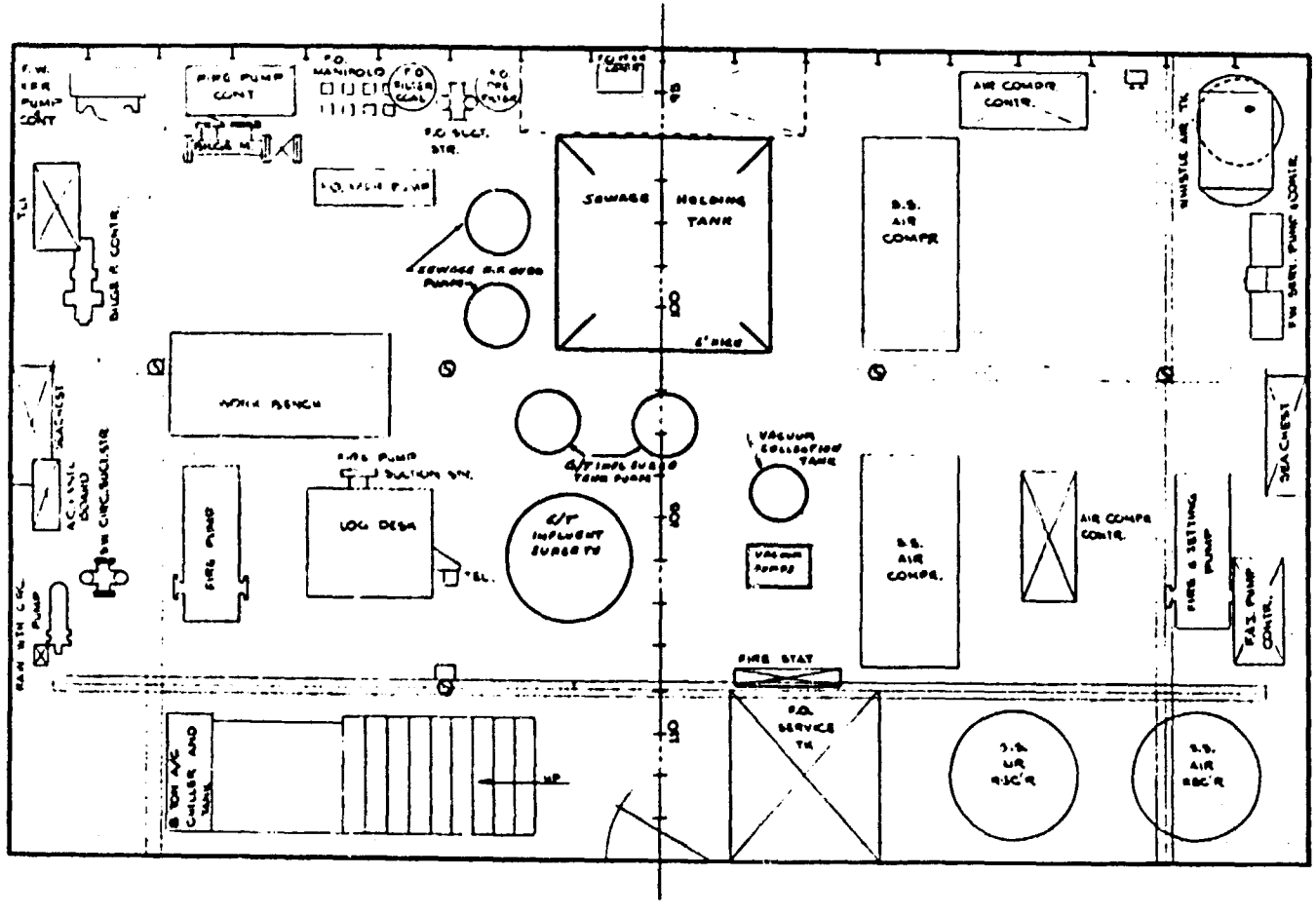
(c) Galley/turbid drains gravitate overboard in unrestricted waters, and to the influent surge tank in restricted waters for transfer to the Grumman feed tank.

(d) The influent surge tank would be pumped to the sewage holding tank for off-loading pierside.

(e) The Grumman effluent tank would discharge overboard.

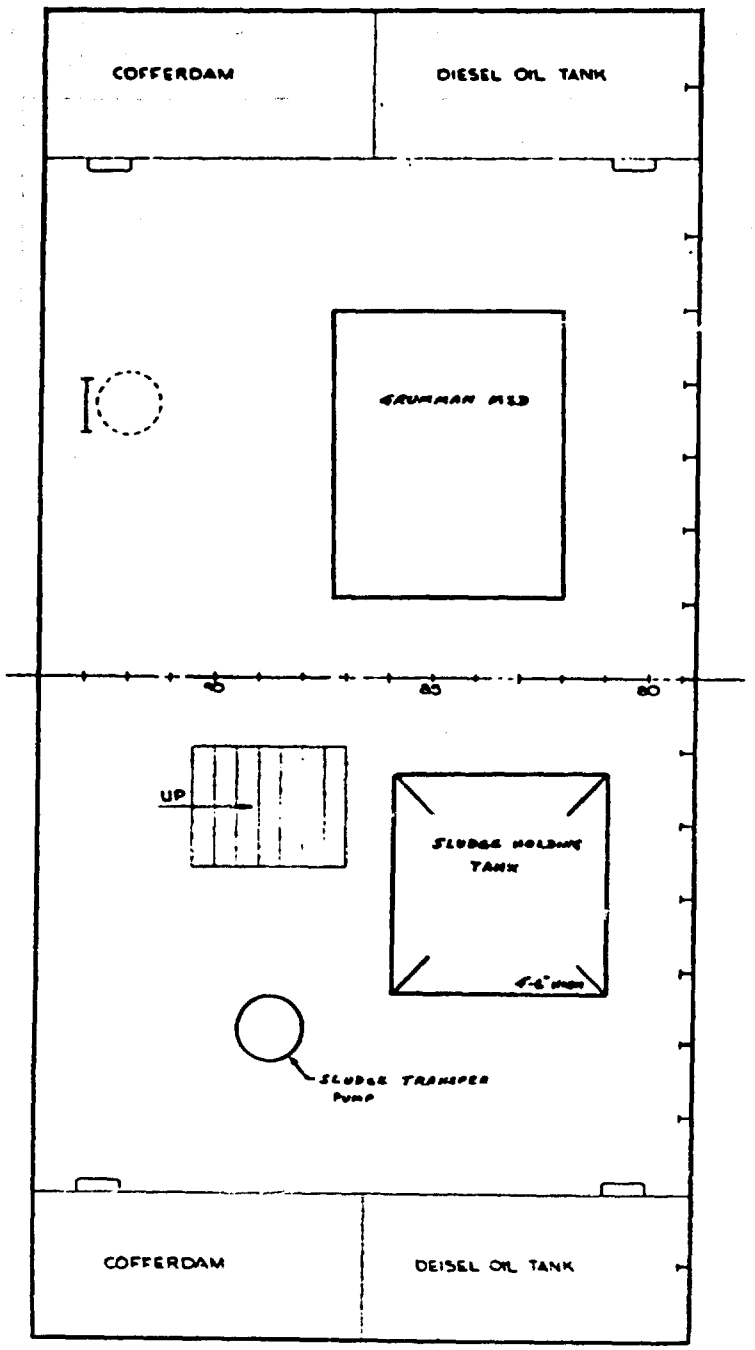
(f) The sludge holding tank is discharged to the sewage holding tank for offloading.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM E-99-0-A
SYSTEM NO. 12
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 2



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES.
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 12
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 12

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	955[2]	4,298
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	4,810[4]	2,646
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	2,650[5]	2,438
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	350	700
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	95	570
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					12,757

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 13 JERED Reduced Volume Flush Vacuum Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required	Approximate Dimensions (L x W x H)
Galley/Turbid Surge Tank	200 gal. (27 cu. ft.)	3' dia. x 4' H
Vacuum Collection Tank	30 gal. (4.4 cu. ft.)	16" dia. x 38" H
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)	1'-6" x 1'-6" x 1'-6"
Grumman Unit with Incinerator	One (1) with One (1) Thiokol Incinerator	
Galley/Turbid Surge Tank Overboard Pump	One (1)	
G/T Surge Tank Pump	One (1)	
VCT Overboard Pump	One (1)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Vacuum collection tank and vacuum pumps in the Auxiliary Machinery Room in place of the existing sewage vacuum equipment.

(b) Galley/turbid influent surge tank forward of the vacuum collection tank.

(c) Influent surge tank pumps and VCT overboard pumps to port of the tank locations.

(d) Grumman unit with incinerator in the Storage Space forward of the Auxiliary Machinery Room, on the starboard side forward.

The incinerator stack run to the weather would be as described for System No. 3.

(e) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

Vessel: PAMLICO (160')

System No. 13 (Cont'd)

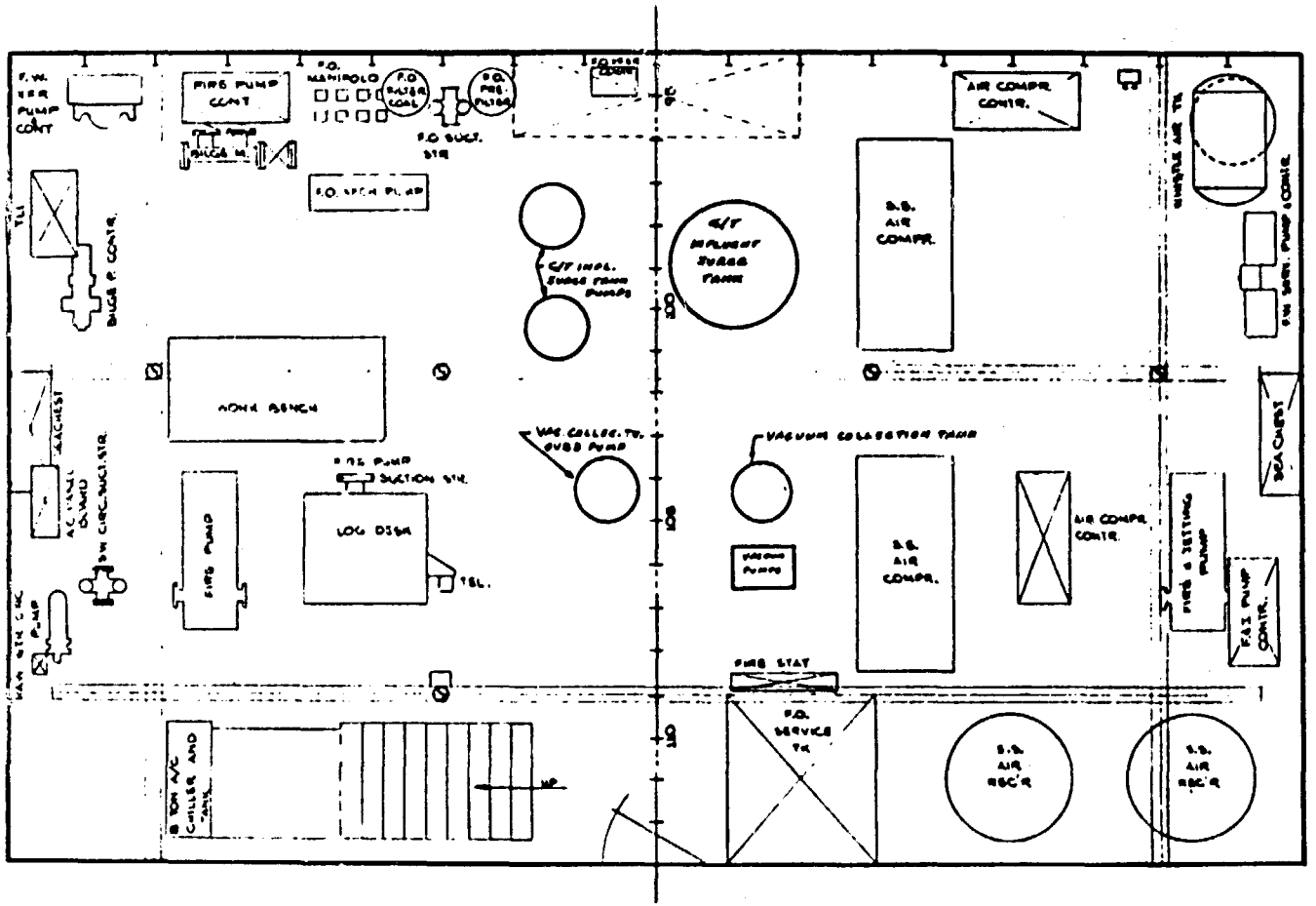
Drainage would be as follows:

(a) Sewage is collected in the vacuum collection tank for transfer to the Grumman sludge feed tank for the incinerator. The collection tank can also be pumped overboard or to pierside according to prevailing restrictions.

(b) Galley/turbid drains gravitate overboard in unrestricted waters and to the G/T surge tank for discharge to the Grumman unit feed tank and to overboard/pierside according to prevailing restrictions.

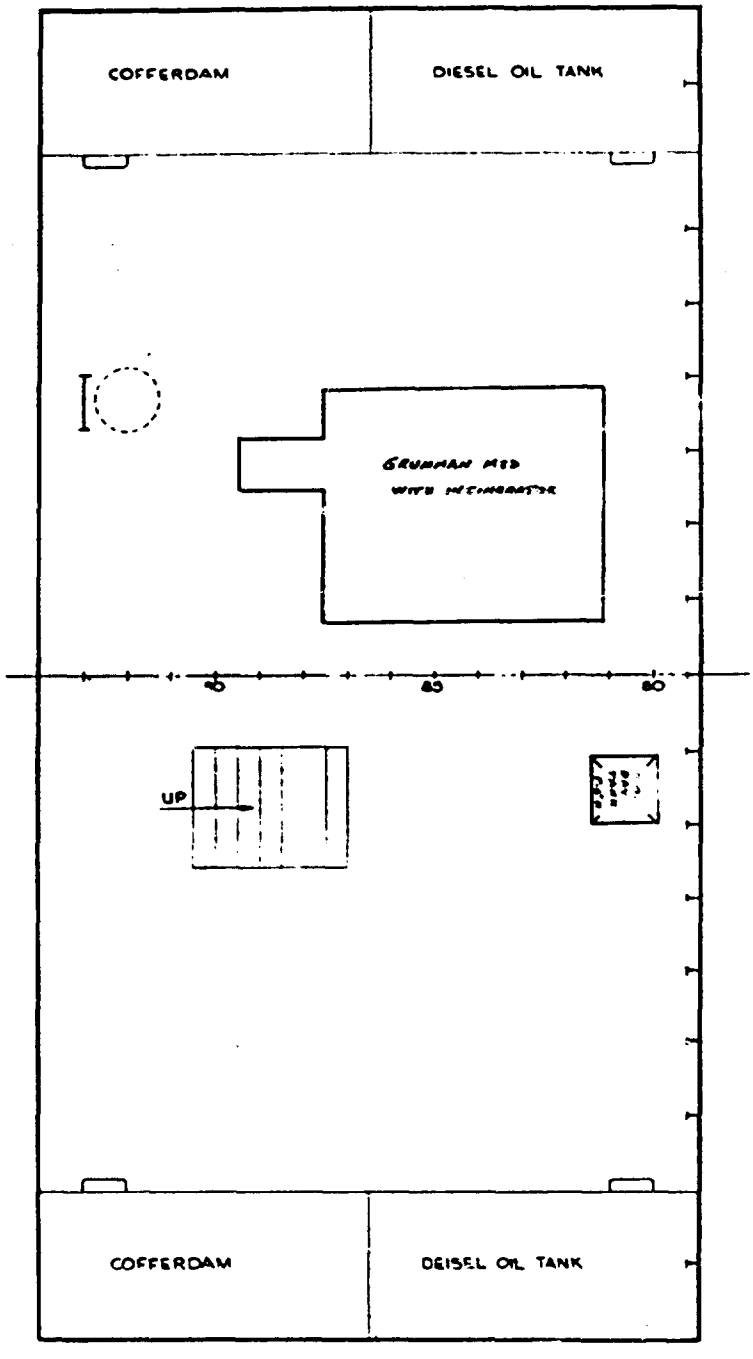
(c) Grumman unit effluent tank discharges overboard.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER FAMLICO
AUXILIARY MACHINERY ROOM E-94-0-8
SYSTEM NO. 13
SCALE 1/8"=1'-0" | SHEET NO. 1 OF 2



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 13
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 13

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,285[2]	10,283
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	875[4]	482
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	795[5]	732
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	350	700
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	25	375
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	65	390
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					14,467

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 14 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Sewage Holding Tank	1,099 gal. (147 cu. ft.)	5' x 5' x 6'
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)	See Discussion
Sewage Holding Tank Discharge Pumps	Two (2)	
Galley Turbid Holding Tank Discharge Pumps	Two (2)	
Macerator/Transfer Pumps	Three (3)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Sewage holding tank in the Auxiliary Machinery Room in the location of the existing sewage holding tank.

The tank's overboard discharge pumps would be located aft of the tank.

(b) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu. ft.). It would eliminate use of the space for any other purpose.

The tank's overboard pumps would be located just aft of the tank on the starboard side.

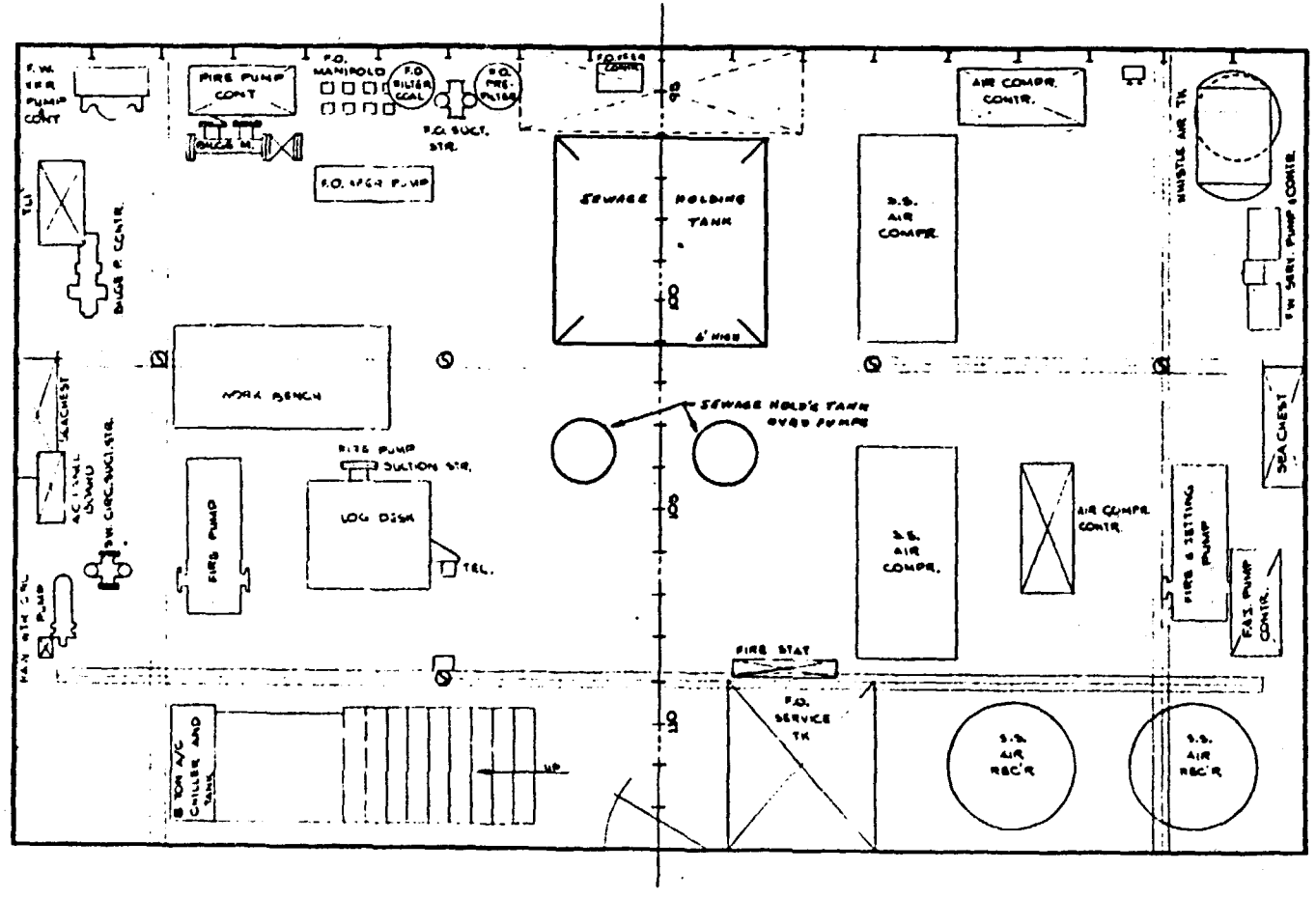
System No. 14 (Cont'd)

Drainage would be as follows:

(a) Sewage would be collected by macerator/transfer pumps and sent to the sewage holding tank for discharge overboard or to pierside according to prevailing restrictions.

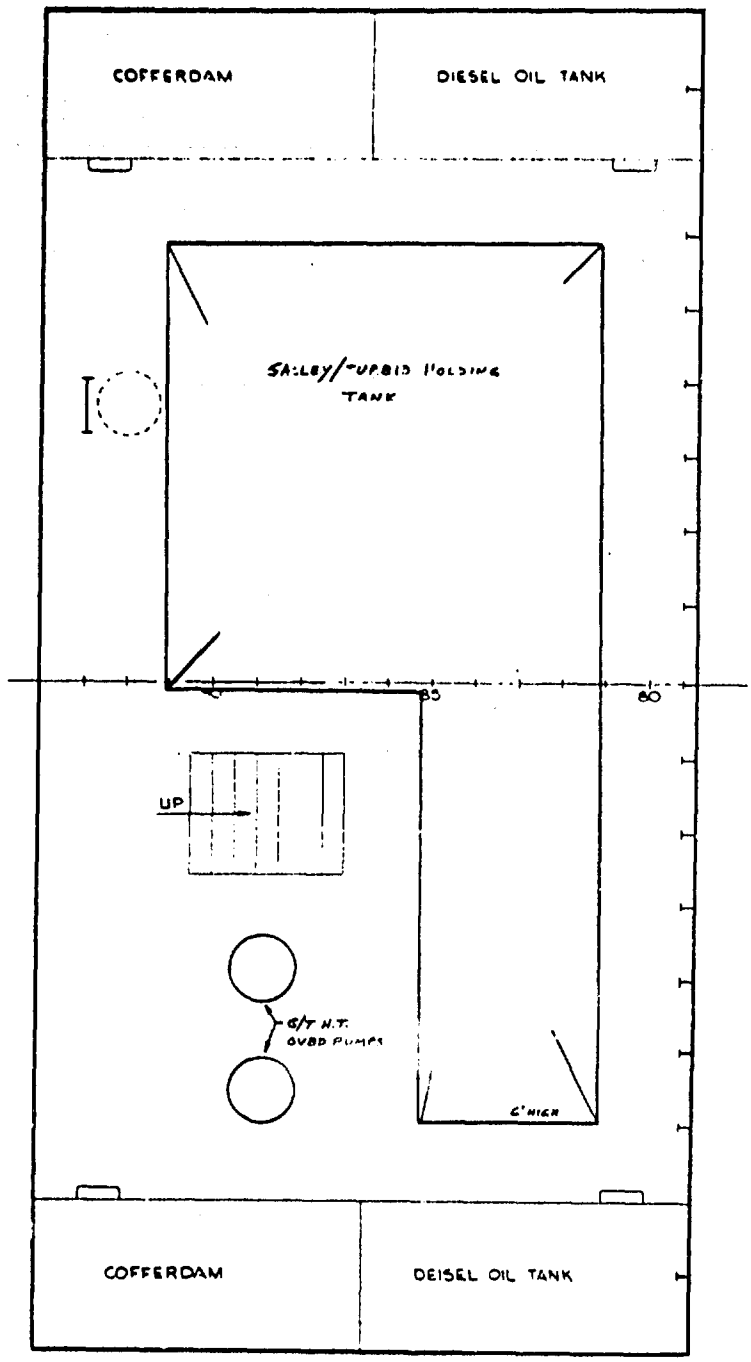
(b) Galley/turbid drains would gravitate overboard in unrestricted waters and would gravitate to the G/T holding tank for retention and discharge overboard and pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM E-94-0-6
SYSTEM NO. 14
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 2



NOTES 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

LHD PT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 14
SCALE 1/8"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 14

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,020[2]	4,590
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	10,775[4]	5,927
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,325[5]	6,739
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	310	620
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	30	30
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	100	600
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					20,481

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 15 GATX Reduced Volume Flush M/T Pump Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Incinerator Feed Tank	50 gal. (6.7 cu.ft.)	2' x 2' x 1'-9"
Galley/Turbid Holding Tank	977 gal. (306 cu.ft.)	See discussion
Fuel Oil Day Tank	28 gal. (3.8 cu.ft.)	1'-6" x 1'-6" x 1'-6"
Incinerator	One (1) Thiokol	
Incinerator Feed Pump	One (1)	
Incinerator Feed Tank Overboard Pump	One (1)	
Galley/Turbid Holding Tank Overboard Pump	Two (2)	
Macerator/Transfer Pumps	Three (3)	

Discussion

The system is a viable candidate subject to certain conditions.

The components would be located as follows:

(a) Incinerator, blower, incinerator feed tank, incinerator feed tank pumps all in the Auxiliary Machinery Room in place of the existing waste disposal system equipment.

The incinerator stack can be run as discussed in System No. 3.

(b) Galley/turbid holding tank taking up available room in all of the Storage Space just forward of the Auxiliary Machinery Room. The tankage would be limited to approximately 6283 gallons (840 cu.ft.). It would eliminate use of the space for any other purpose.

(c) G/T holding tank overboard pumps could be accommodated in the Auxiliary Machinery Room in the present location of the sewage holding tank.

(d) Installation of an incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

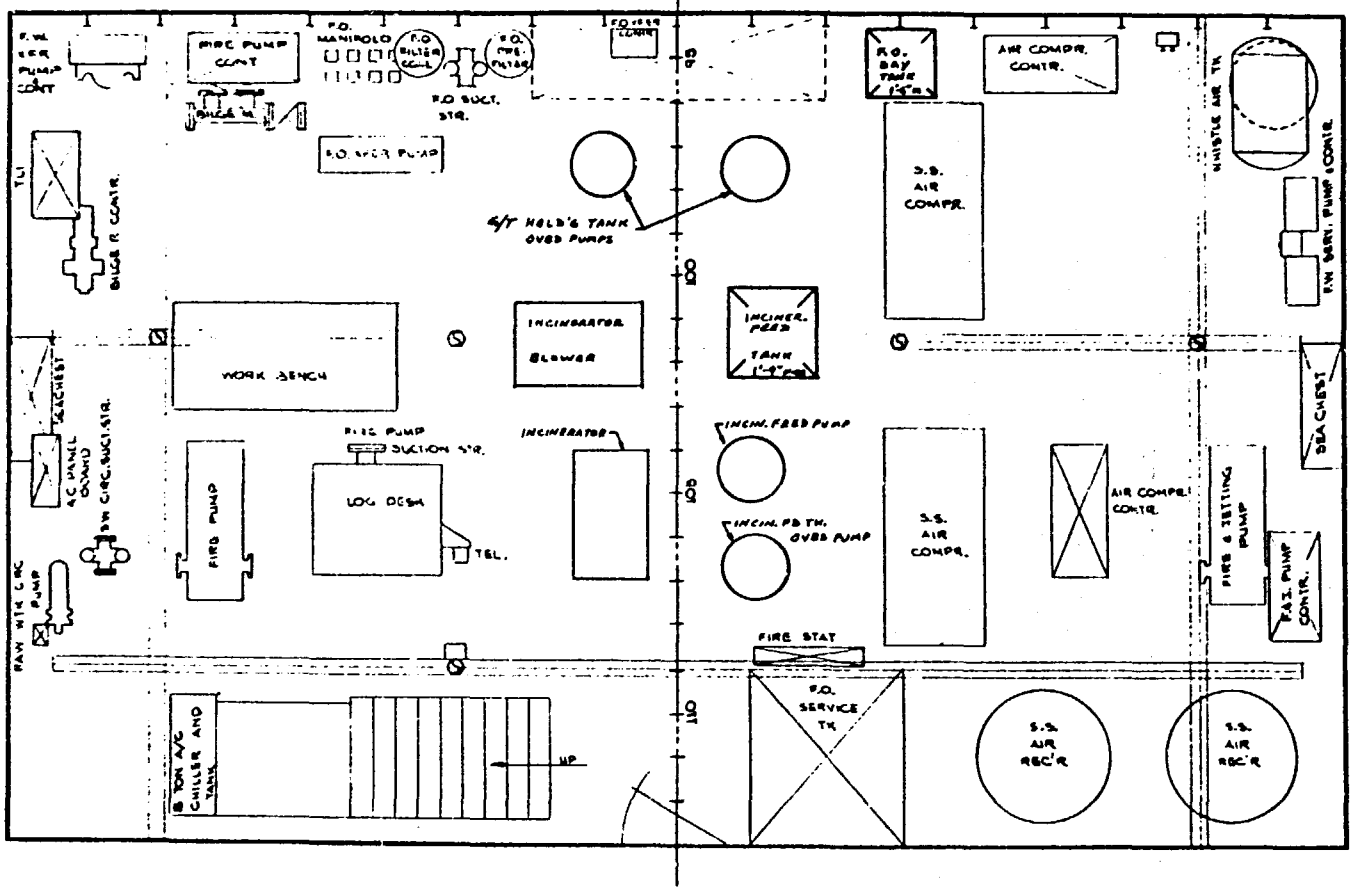
Drainage would be as follows:

(a) Sewage would be collected by macerator/transfer pumps and discharged to the incinerator feed tank.

(b) The incinerator feed tank contents can be fed to the incinerator or, when permitted, discharged overboard, or to pierside.

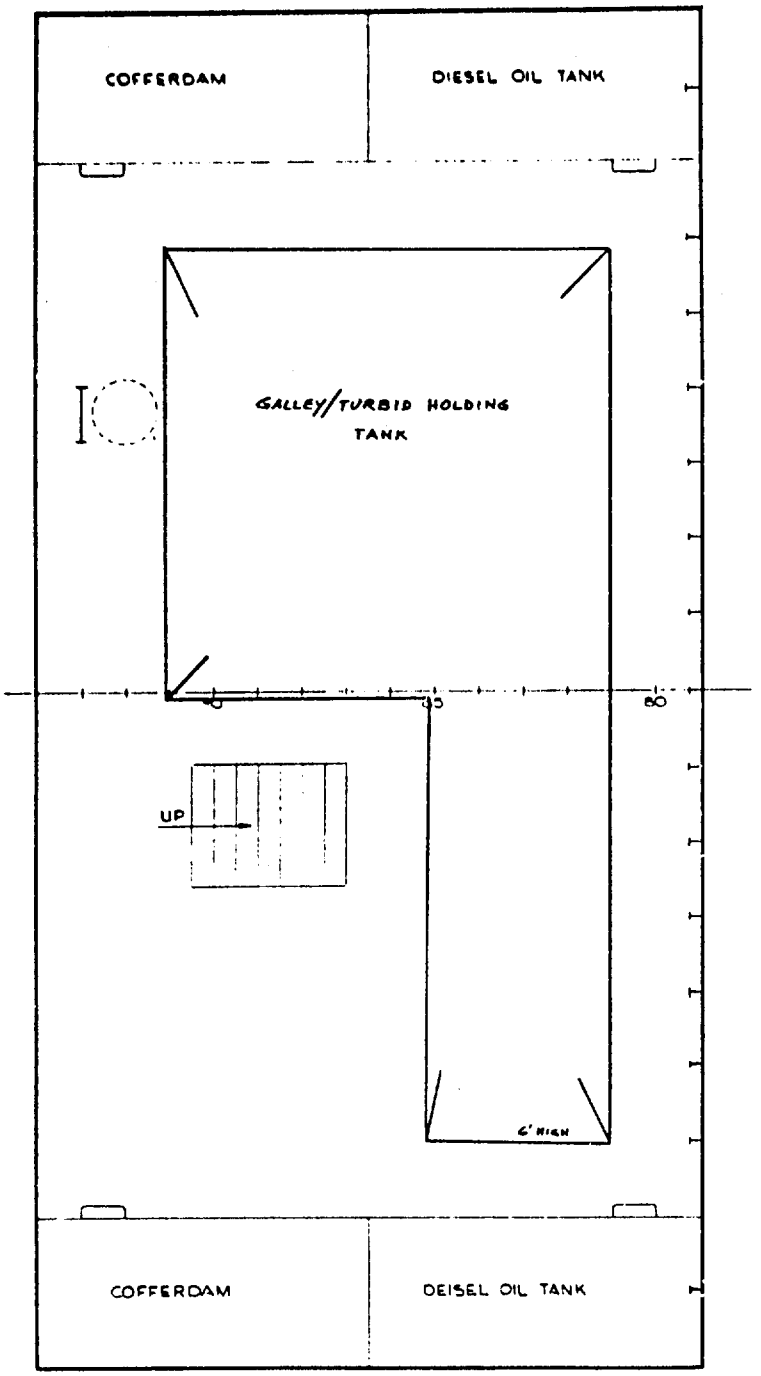
(c) Galley/turbid drain gravitate overboard in unrestricted waters and gravitate to the G/T holding tank for discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES : 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM E-94-0-B
SYSTEM NO. 15
SCALE 1/8"=1'-0" | SHEET NO. 1 OF 2



NOTE : TANK HEIGHT TAKEN FROM FLOOR PLATES

LEO ET CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 16
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 15

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,955 [2]	8,798
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,995 [4]	4,948
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,410 [5]	5,898
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	325	650
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	40	40
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	105	630
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					22,939

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 16 GATX Reduced Volume Flush M/T Pump Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Galley/Turbid Holding Tank	9770 gal. (1306 cu.ft.)	See discussion
Evaporator (GATX)	One (1) - 40 gal.	
Catalytic Oxidizer	One (1)	
Galley/Turbid Holding Tank Overboard Pumps	Two (2)	
Macerator/Transfer Pumps	Three (3)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Evaporator and associated equipment in the Auxiliary Machinery Room in place of the existing sewage holding tank.

(b) Galley and turbid holding tank in the Storage Space just forward of the Auxiliary Machinery Room, taking up all available space. The tankage would be limited to approximately 6283 gallons (840 cu.ft.). It would eliminate use of the space for any other purposes.

(c) G/T holding tank overboard pumps can be fitted in the Auxiliary Machinery Room aft of the GATX Evaporator.

Drainage would be as follows:

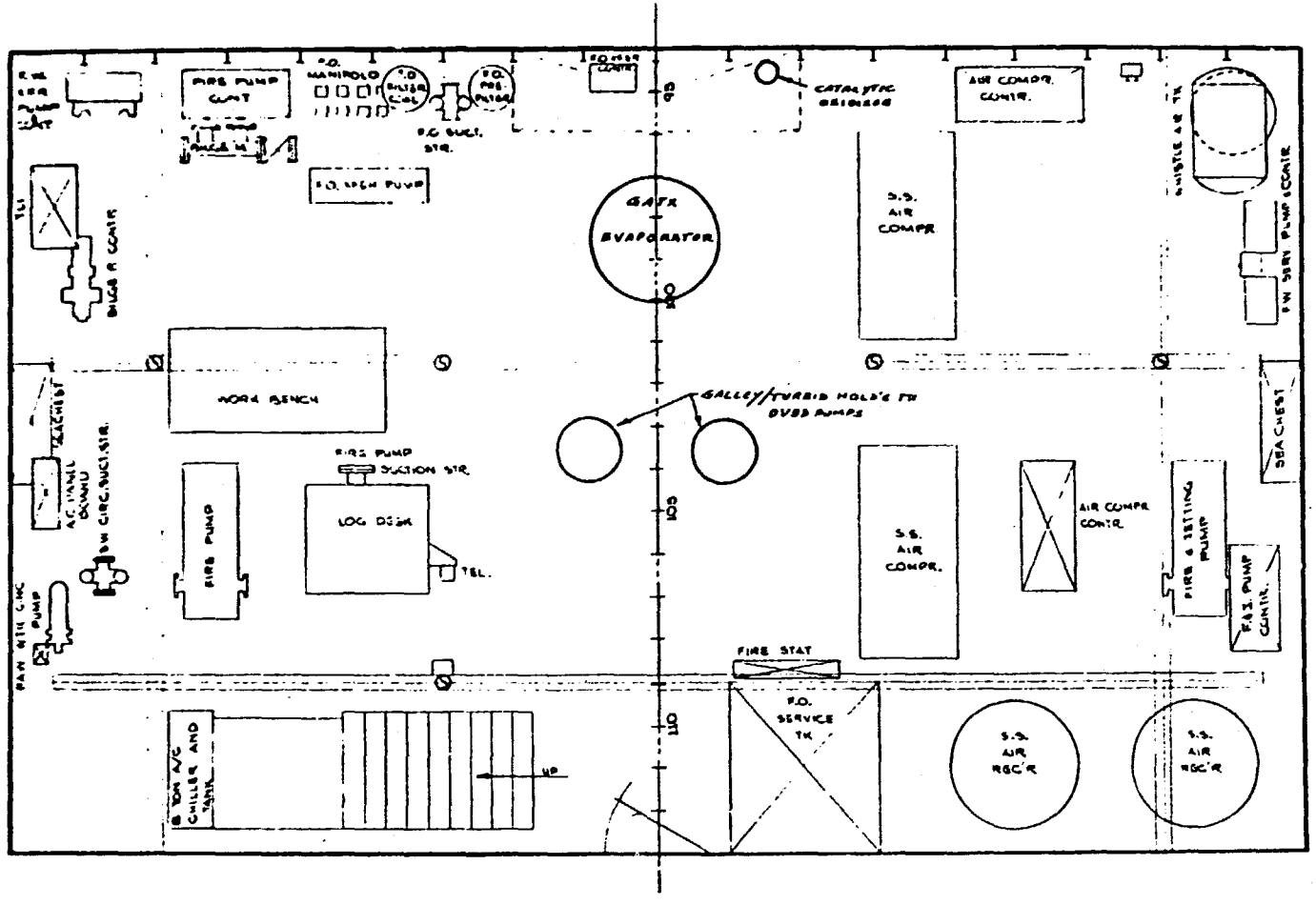
(a) Sewage would be collected by macerator/transfer pumps and sent to the evaporator. The pumps could also discharge directly overboard or to pierside connections according to prevailing restrictions.

System No. 16 (Cont'd.)

(b) The evaporator sludge can be discharged overboard or to pierside.

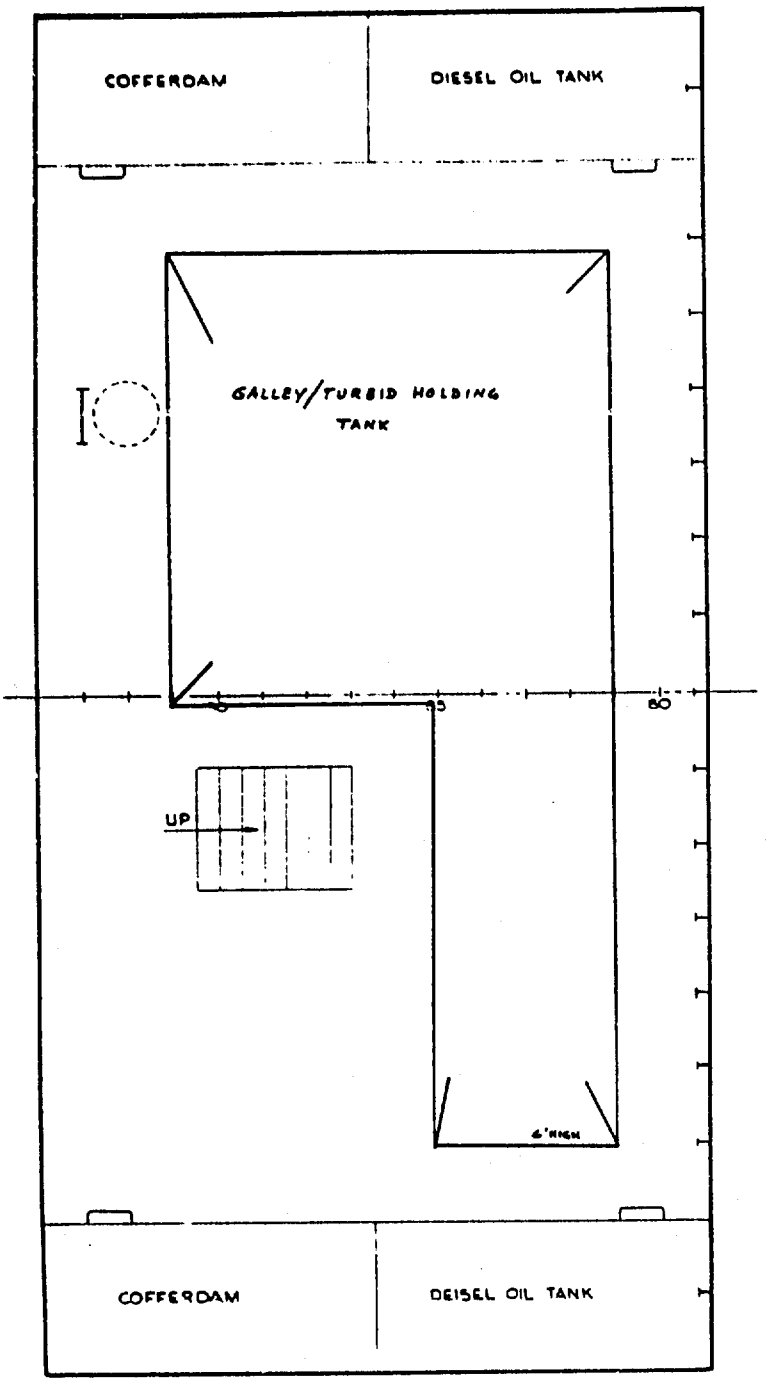
(c) Galley/turbid drains gravitate overboard in unrestricted waters and to the G/T holding tank for retention and discharge overboard/pierside according to prevailing restrictions.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM 2-99-0-E
SYSTEM NO. 16
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 2



NOTE : TANK HEIGHT TAKEN FROM FLOOR PLATES

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 16
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 16

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,055 [2]	4,748
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,515 [4]	4,684
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,245 [5]	5,746
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	130	260
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	40	40
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	90	540
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					17,768

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 17 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required	Approximate Dimensions (L x W x H)
Sewage Holding Tank	1099 gal. (147 cu.ft.)	5' x 5' x 6'
Galley/Turbid Influent Surge Tank	200 gal. (27 cu.ft.)	3' dia. x 4' H
Sludge Holding Tank	814 gal. (109 cu.ft)	5' x 5' x 4'-6"
Grumman Unit without Incinerator	One (1)	
Sewage Holding Tank Overboard Pumps	Two (2)	
Sludge Tank Transfer Pump	One (1)	
Influent Surge Tank Pumps	Two (2)	
Macerator/Transfer Pumps	Three (3)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Sewage holding tank in the Auxiliary Machinery Room in place of the existing sewage holding tank.

(b) Sewage holding tank overboard pumps to port of the tank.

(c) Galley/turbid influent surge tank and pumps just aft of the sewage holding tank.

(d) Grumman unit and sludge holding tank at the forward end of the Storage Space just forward of the Auxiliary Machinery Room.

(e) Sludge holding tank transfer pump just aft of the tank on stbd. side of the space.

System No. 17 (cont'd.)

Drainage would be as follows:

(a) Sewage would be collected by macerator/transfer pumps and discharged to the sewage holding tank which would, in turn, be pumped overboard and pierside.

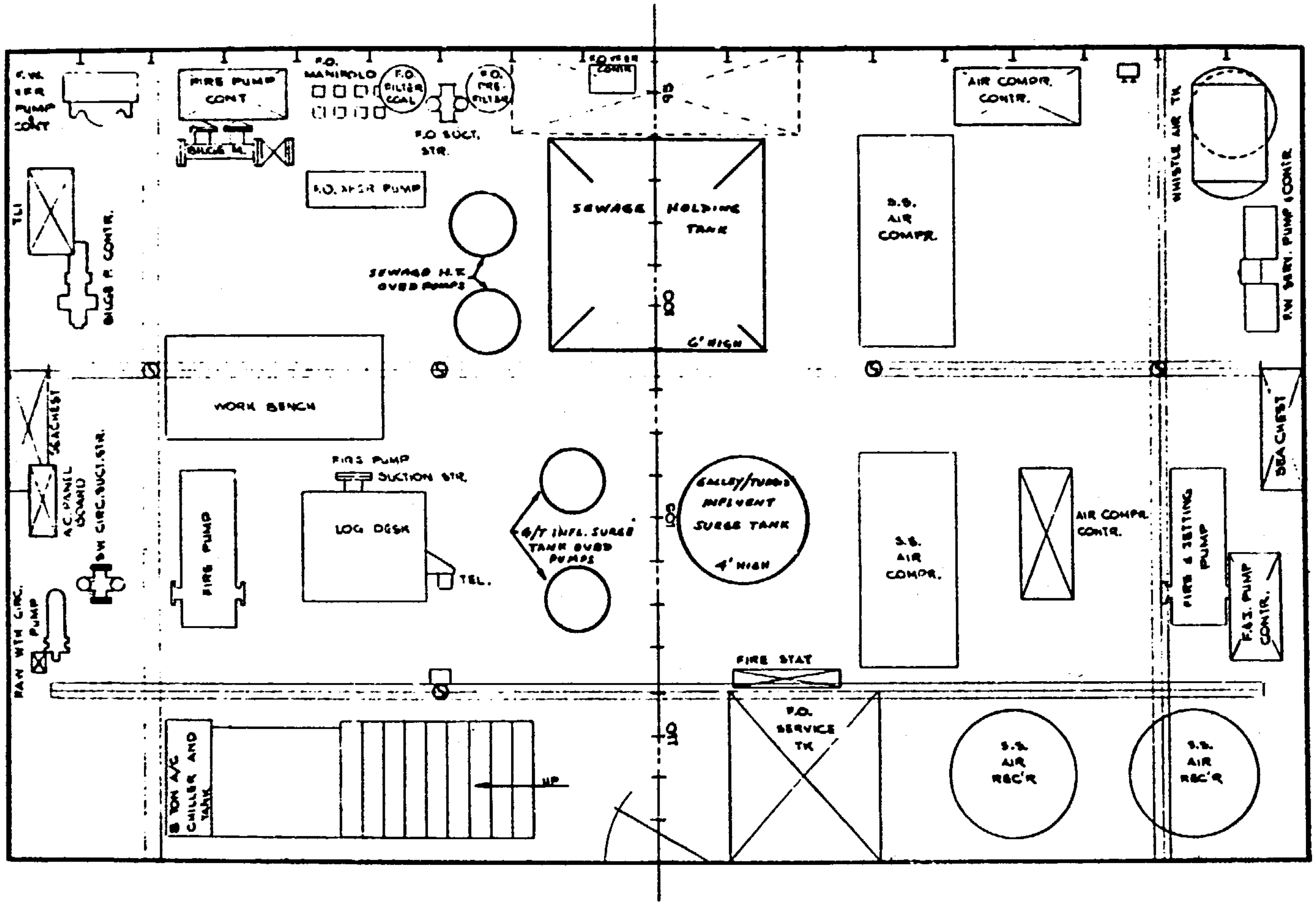
(b) Galley/turbid drains would gravitate overboard in unrestricted waters and to the influent surge tank in restricted waters for transfer to the Grumman feed tank.

The influent surge tank could be pumped to the sewage holding tank for discharge pierside.

(c) Grumman effluent tank discharges overboard.

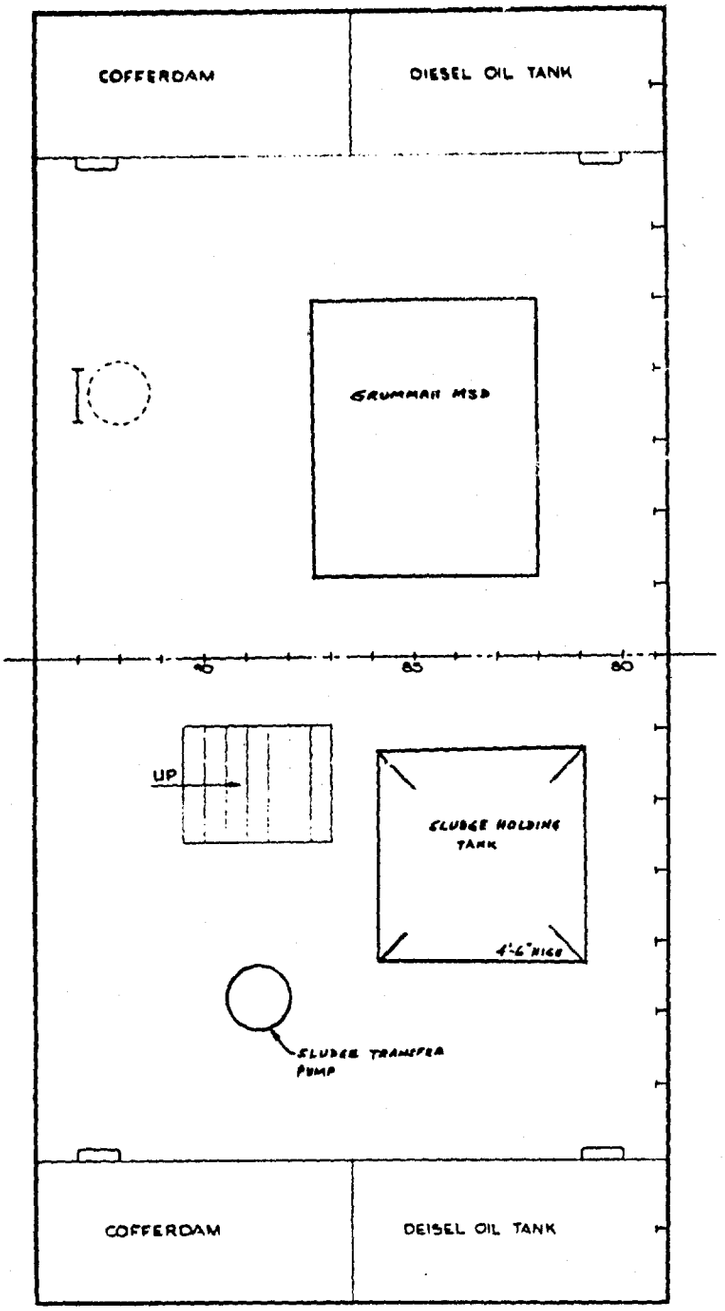
(d) Sludge holding tank transfers contents to the sewage holding tank for discharge overboard or pierside.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

160 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM 2-94-0-E
SYSTEM NO. 17
SCALE 1/2"=1'-0" — SHEET NO. 1 OF 2



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACES 2-79-0-A
SYSTEM NO. 17
SCALE 1/2"=1'-0" | SHEET NO 20 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 17

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,120 [2]	5,040
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	4,810 [4]	2,646
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	2,620 [5]	2,411
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	350	700
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	55	55
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	95	570
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	20	1,000
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					13,472

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: PAMLICO (160')

WMS No. 18 GATX Reduced Volume Flush M/T Pump Collection/Grumman Flow Through System for Gray Water/Incincerator for both Concentrated Black Water and Gray Water Sludge

	Required	Approximate Dimensions (L x W x H)
Sewage Surge Tank	26 gal.(3.5 cu.ft.)	1'-6" x 1'-6" x 1'-9"
Galley/Turbid Surge Tank	200 gal. (27 cu.ft.)	3' dia. x 4' H
Fuel Oil Day Tank	25 gal. (3.3 cu.ft.)	1'-6" x 1'-6" x 1'-6"
Grumman Unit with Incinerator	One (1) with One (1) Thiokol Incinerator	
Sewage Surge Tank Transfer Pump	One (1)	
Sewage Surge Tank Overboard Pump	One (1)	
Galley/Turbid Surge Tank Pump	One (1)	
Galley/Turbid Surge Tank Overboard Pump	One (1)	
Macerator/Transfer Pump	Three (3)	

Discussion

The system is a viable candidate subject to certain considerations.

The components would be located as follows:

(a) Sewage surge tank in the Auxiliary Machinery Room, to port of the vessel's centerline near the location of the present sewage holding tank.

(b) Galley/turbid influent surge tank to stbd. of the sewage surge tank.

(c) Various pumps associated with the equipment fitted in the Auxiliary Machinery Room would be located aft of the sewage surge tank and G/T influent surge tank.

(d) Grumman unit with incinerator in the Storage Space just forward of the Auxiliary Machinery Room, stbd. side. The incinerator stack would be run as discussed in System No. 3.

(e) Installation of the incinerator may require additional fire protection equipment and modification of the ventilation system for the space.

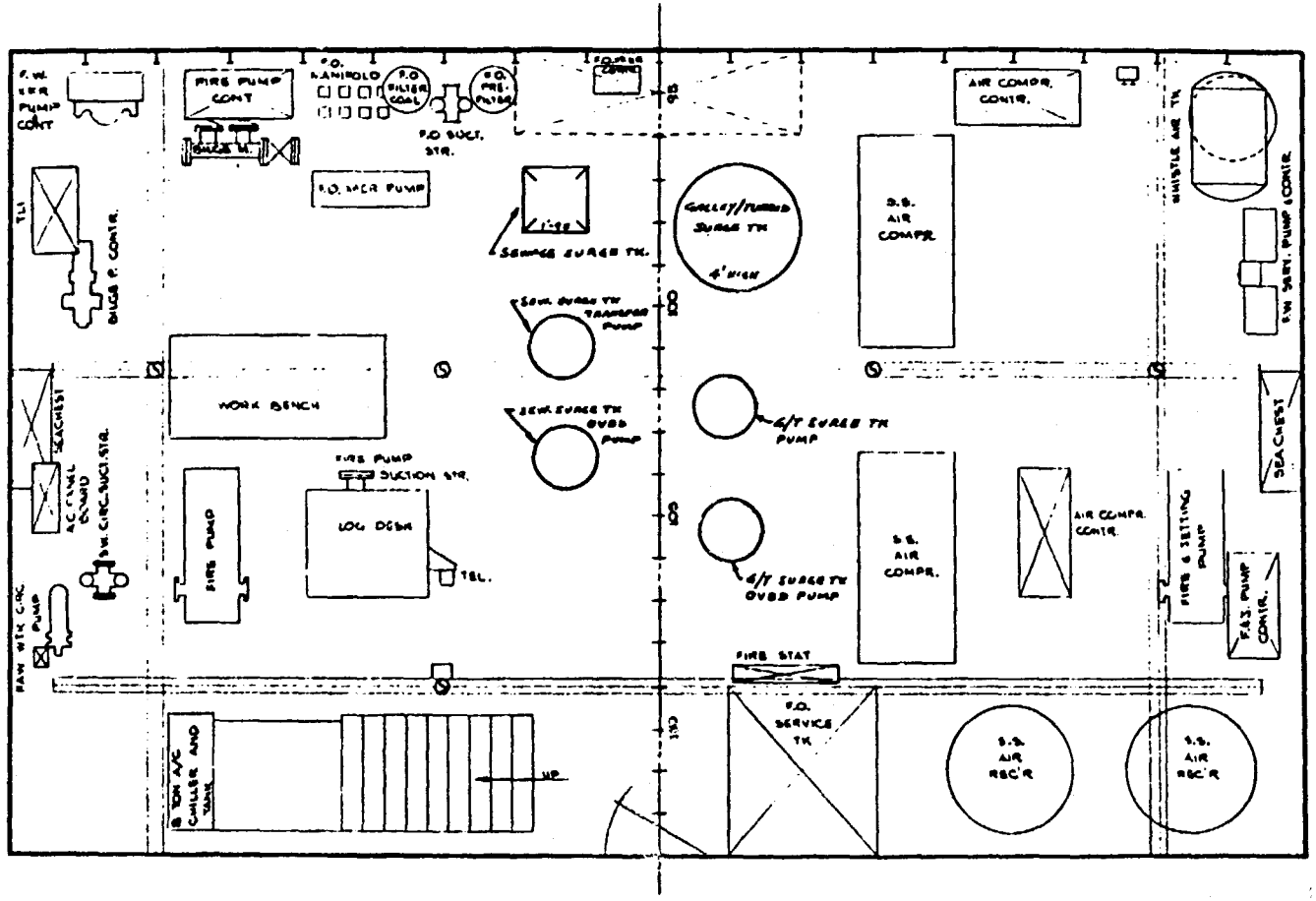
Drainage would be as follows:

(a) Sewage is collected by macerator transfer pumps for discharge to the sewage surge tank from which it would be pumped to the Grumman sludge feed tank for the incinerator, or overboard/pierside according to prevailing restrictions.

(b) Galley/turbid drains gravitate overboard in unrestricted waters and gravitate to the G/T surge tank for transfer to the Grumman feed tank or overboard/pierside according to prevailing restrictions.

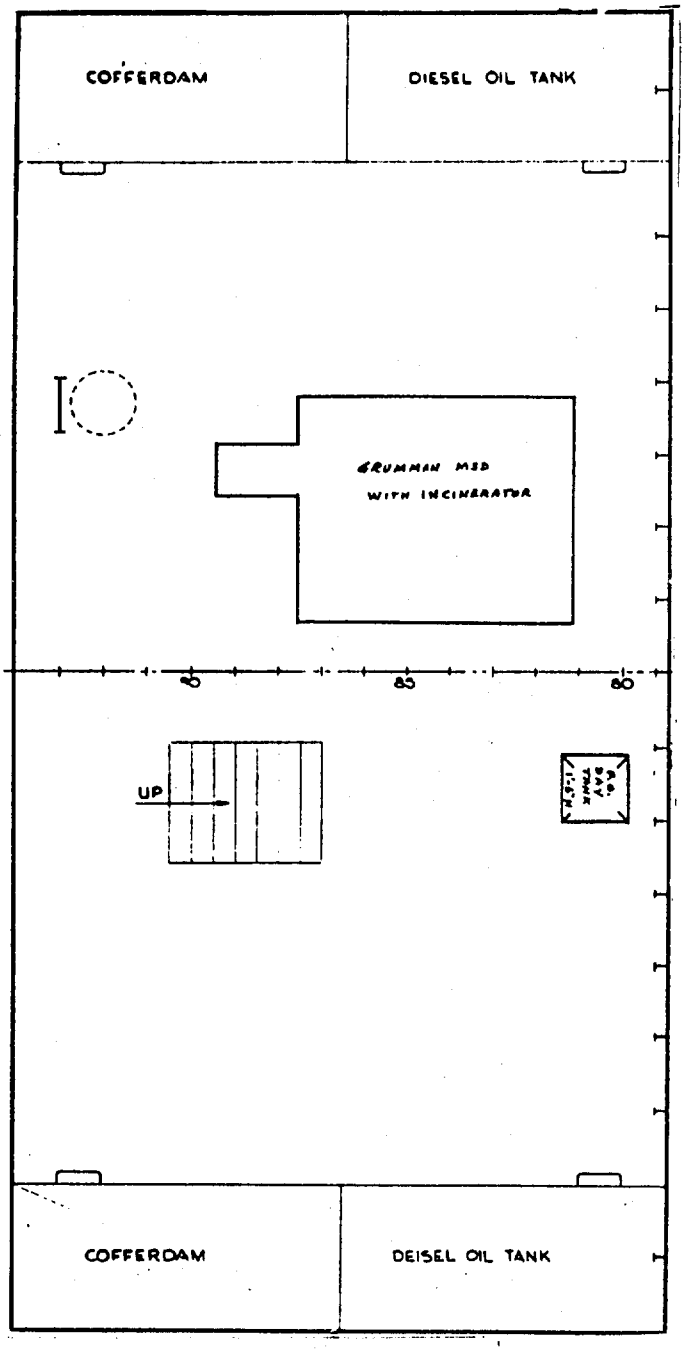
(c) Grumman unit effluent tank would be pumped overboard.

PROPOSED WMS EQUIPMENT ARRANGEMENT



NOTES: 1. TANK HEIGHT TAKEN FROM FLOOR PLATES
2. PUMPS NOT TO SCALE

180 FT. CONSTRUCTION TENDER PAMLICO
AUXILIARY MACHINERY ROOM E-94-0-8
SYSTEM NO. 18
SCALE 1/2"=1'-0" | SHEET NO. 1 OF 1



NOTE : TANK HEIGHT TAKEN FROM FLOOR PLATES

180 FT CONSTRUCTION TENDER PAMLICO
STORAGE SPACE 2-79-0-A
SYSTEM NO. 18
SCALE 1/2"=1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel PAMLICO (160')

WMS No. 18

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,935[2]	8,708
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	1,075[4]	592
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	800[5]	736
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	350	700
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	30	30
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	55	330
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	20	1,000
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	30	450
Total Installation Cost ($)					13,071

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 1 of 10

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION

INSTALLATION CHARACTERISTIC

Factor/Subfactor Ident. No.

111 Required black water handling capacity for vessel versus actual capacity of WMS

(a) Actual capacity of WMS equals or exceeds required capacity for vessel.
(b) WMS marginally suitable for vessel (has 95-99% of required capacity).
(c) WMS capacity insufficient for vessel (less than 95% of required capacity).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

112 Required gray water handling capacity for vessel versus actual capacity of WMS

(a) Actual capacity of WMS equals or exceeds required capacity for vessel.
(b) WMS marginally suitable for vessel (has 95-99% of required capacity).
(c) WMS capacity insufficient for vessel (less than 95% of required capacity).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c	c	a	a	c	a	c	c	c	a	a	c	c	c	a	a

13 Extent of additional support systems or equipment required to accommodate WMS[1]

(a) No additional support systems or equipments required.
(b) Some additional support systems or equipments required.[2]
(c) Many additional support systems or equipments required.[3]

[1] Examples: . Firefighting system must be installed with incinerator.
. Bilge alarm required if large tank is installed above bilge.
. Compressor required on vessels that do not already have one.
. Detectors of toxic or noxious gases should be installed with any system that, as an inherent design feature, uses such gases in processing wastes.

[2] Need for support system/equipment does not significantly reduce WMS suitability for on-board installation.
[3] Suitability of WMS for installation on vessel significantly reduced.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

21 Extent of fixture modifications required for WMS installation

(a) No fixtures need modification or replacement.
(b) Some fixtures need modification or replacement.
(c) All commodes need replacement and modification of urinal-associated equipment (e.g., urinal discharge valves) is required.
(d) All fixtures need replacement or modification (e.g., replacement or commodes and urinal flushometers).
(e) All fixutres need replacement or modification and each fixture has additional hookup requirements associated with it.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	d	d	d	d	d	d	d	d	e	e	e	e	e	e	e	e	e	e

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const.

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

22 Extent of flush medium supply modifications required for WMS installation

(a) Existing flush medium is used.
(b) WMS requires conversion of flush medium to potable water.
(c) WMS requires conversion of flush medium to recirculating non-aqueous medium.
(d) WMS requires conversion of flush medium to salt water.(1)

(1) Conversion to salt water requires pump re-sizing, tapping into the sea-chest and provision for its corrosive properties. For PAMLICO, salt water would be used if the drain system were converted to a standard flush system (C.G. supplied information).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	d	c	c	d	d	d	d	d	a	a	a	a	a	a	a	a	a	a

231 Hookup requirements(1) for WMS Collection/Transport subsystem installation

(a) No additional hookup requirements beyond existing ones.
(b) Requires piping for recirculation of flush medium (in existing gravity drain system).
(c) Special and centralized Collection/Transport subsystem required.
(d) Special and non-centralized Collection/Transport subsystem required (includes conversion from reduced flush vacuum collection to a standard gravity drain system, with or without recirculation).

(1) Drain piping; electric cables connecting commode, M/T pump and control panel in GATX, but not in JERED, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	d	d	d	d	d	d	d	d	a	a	a	a	a	d	d	d	d	d

232 Routing flexibility for drain piping modifications(1) associated with WMS Collection/Transport subsystem installation(2)

(a) Routing is highly flexible.(3)
(b) Routing is moderately flexible, with some restrictions.
(c) Routing is highly inflexible.

(1) Of the three relevant categories of routing of lines (piping, ventilation, electrical), piping is the most important for assessing use of WMS installation.

(2) Notes: . With gravity drainage, lines must always slope downward and require venting.
. Smaller size lines are inherently more flexible.
. With the pump or vacuum Collection/Transport subsystem, sharp bends, rises and long runs can be accommodated in piping.

(3) In all cases, WMS installation is to be considered from the point of view of modifications required to existing conditions.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	a	a	a	a	a	b	b	b	b	b

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 3 of 10

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

Factor/Subfactor Ident. No.

233 Space requirements for WMS Collection/Transport subsystem installation.

(a) No additional space required.(1)
(b) Some additional space required.(2)
(c) Large amount of additional space required.

(1) E.g., M/T pumps in GATX; or small influent surge tank.
(2) E.g., large VCT in JERED; or large influent surge tank, if not already installed.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	b	b	b	b	b	a	a	a	a	a	a	a	a	a	a

234 Modularity of WMS Collection/Transport subsystem (as it affects installation)(1)

(a) Degree of modularity of subsystem aids in installation of C/T subsystem.
(b) Degree of modularity of subsystem results in some (minimal) difficulty in installation of C/T subsystem.
(c) Degree of modularity of subsystem results in moderate difficulty in installation of C/T subsystem.

(1) On vessels that do not currently have a WMS, a high degree of modularity aids in installation, and a high degree of subsystem centralization (as in the JERED) results in difficulties for installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

235 Vent requirements for WMS Collection/Transport subsystem installation

(a) No vents are required other than the existing vents.
(b) Few vents are required in addition to the existing vents.
(c) Many vents are required in addition to existing vents.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	b	b	b	b	b	a	a	a	b	b	b	b	b	b	b

241 Space requirements for WMS waste Treatment/Disposal subsystem installation

(a) Volume required is minimal and dimensions(1) of equipment present no problems in fitting equipment into available compartment space.
(b) Volume required is moderate and dimensions(1) of equipment present no problems in fitting equipment into available compartment space.
(c) Volume and dimension(1) of equipment do present problem in fitting equipment into available compartment space.
(d) Large volume required and dimension(1) of equipment do present problem in fitting equipment into available compartment space.

(1) The two main factors are (i) deck area required and (ii) height required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 4 of 10

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

242 Hookup requirements[1] for WMS waste Treatment/Disposal subsystem installation

(a) Pipes, ducts and/or cable requirements are minimal.
(b) Pipes, ducts and/or cable requirements are moderate.
(c) Pipes, ducts and/or cable requirements are extensive.

[1] Piping for fuel oil, fresh water, cooling water, compressed air, interconnecting remotely located equipment, overboard discharge line, etc.; electric cables for power supply, remote control panels, etc.; ducting for ventilation, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c	c	c	c	c	c	b	b	b	b	b	b	b	b	b	b

243 Degree of modularity of WMS waste Treatment/Disposal (as it affects installation)[1]

(a) Degree of modularity of subsystem aids in installation of T/D subsystem.
(b) Degree of modularity of subsystem results in some (minimal) difficulty in installation of T/D subsystem.
(c) Degree of modularity of subsystem results in moderate difficulty in installation of T/D subsystem.

[1] Decentralization of components may require additional hookups and piping runs.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

244 Vent requirements for WMS waste Treatment/Disposal subsystem installation[1]

(a) No vents are required.
(b) Vents are required.

[1] Vents that are only internal to the compartment in which subsystem is located are not considered here.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

245 Exhaust stack requirements for WMS waste Treatment/Disposal subsystem installation[1]

(a) Exhaust not required.
(b) Exhaust required, size of stack relatively small and stack <u>can</u> be run via existing ship's stack enclosure (fiddley).
(c) Exhaust required, size of stack relatively large and stack <u>can</u> be run via existing ship's stack enclosure.
(d) Exhaust required, size of stack relatively small and stack <u>cannot</u> be run via existing ship's stack enclosure.
(e) Exhaust required, size of stack relatively large and stack <u>cannot</u> be run via existing ship's stack enclosure.

[1] Notes: . Electric incinerator requires small (2") exhaust.
. Fuel incinerator requires large (10") exhaust.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	c	a	a	a	c	c	a	c	a	a	c	a	c	a	a	c

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 5 of 10

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

25 Ease of installing WMS support equipment[1]

(a) No support equipment required.
(b) Some support equipment required but easy to install.
(c) Much support equipment required and difficult to install.

[1] Examples:
- Firefighting system must be installed with incinerator.
- Bilge alarm required if large tank is installed above bilge.
- Compressor required on vessels that do not already have one.
- Detectors of toxic or noxious gases should be installed with any system that, as an inherent design feature, uses such gases in processing wastes.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

26 Ease of compensating for added weight of WMS

(a) No or minimal compensation for added weight required.
(b) Moderate compensation for added weight required.
(c) Extensive compensation for added weight required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	-	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

271 Extent of SHIPALTS (permanent modifications) required for WMS installation[1]

(a) No SHIPALTS required.
(b) Minor SHIPALTS required.
(c) Extent of SHIPALTS required is moderate.
(d) Extensive SHIPALTS required.

[1] Foundations, enlarged doors/hatches, increased capacity requirements for air compressor, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	d	d	d	d	d	d	d	d	c	c	c	c	c	c	c	c	c	c

272 Extent of temporary modification[1] required for WMS installation

(a) No temporary modifications required.
(b) Temporary modifications required are minor.
(c) Extent of temporary modifications required are moderate.
(d) Temporary modifications required are extensive.

[1] Cutting access openings, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const.

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

31 Effect of WMS on vessel stability

(a) No effect on existing stability characteristics of vessel.
(b) Some effect on existing stability characteristics of vessel, easily compensated for.
(c) Severe effect on existing stability characteristics of vessel, compensation required extensive modifications to vessel (e.g., no tankage in Point Herron).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

32 Effect of WMS on vessel trim and list

(a) No effect on trim or on list.
(b) Some easily compensated for effect on trim or list.
(c) Compensation for effect on trim or list requires extensive modification to vessel.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

33 Effect of WMS on normal range of vessel

Vessel resource capacity and usage rates.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	- Presented on Vessle Resource Data Sheets -																	

34 Degree of space trade-off/reallocation required for WMS installation

(a) No space trade-off/reallocation required.
(b) Minimal degree of space trade-off/reallocation required.
(c) Moderate degree of space trade-off/reallocation required.
(d) High degree of space trade-off/reallocation required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

M/E II - PERFORMANCE

PERFORMANCE CHARACTERISTIC

12 WMS per capita wet weight (lb)[1] = W_i

[1] Drain piping material is assumed to be copper-nickel (Cu-Ni).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	8565	6856	6106	6220	1909	4368	6233	1220	6512	5853	5577	2538	1105	6635	5805	5619	2559	1108

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const.

M/E II - PERFORMANCE (Cont'd)

Factor/Subfactor Ident. No.	PERFORMANCE CHARACTERISTIC
13	WMS per capita volume (ft^3)(1) - V_1 (1) Volumes are calculated as follows: • Fixture volumes are calculated using smallest space envelopes. • Pipe volume is the volume of a square tube with side = outside diameter of pipe. • Other equipment: Deck area: smallest rectangle enclosing all equipment in a single package plus extra dimension area required for operation and maintenance. Height: either maximum height of equipment, or full compartment height, if space above package is not usable for any other purposes.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	279.6	287.3	289.3	289.3	149.8	224.6	281.6	73.8	271.1	199.8	187.8	193.8	124.8	252.5	199.8	167.2	187.9	118.9

21	Adequacy of WMS black water holding times HT_b - % of required black water holding time met by WMS(1) (1) A WMS which employs an incinerator is considered to meet 100% of the required holding time. The holding time of a WMS which employs a holding tank (for wastewater or sludge) is determined by the ratio of available tank capacity to required capacity.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

22	Adequacy of WMS gray water holding times HT_g - % of required gray water holding time met by WMS(1) (1) A WMS which employs an incinerator is considered to meet 100% of the required holding time. The holding time of a WMS which employs a holding tank (for wastewater or sludge) is determined by the ratio of available tank capacity to required capacity.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	55	64	64	64	100	100	64	100	64	64	64	100	100	64	64	64	100	100

311	Effect of peak hydraulic loads in black water stream on WMS performance $GIST_b$ - % of required Grumman (or other) influent surge tank capacity in black water stream met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	--	--	--	100	100	--	100	100	--	--	--	---	--	--	--	--	--	100

312	Effect of peak hydraulic loads in gray water stream on WMS performance $GIST_g$ - % of required Grumman influent surge tank capacity in gray water stream met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	--	--	--	--	100	100	--	100	--	--	--	100	100	--	--	--	100	100

331	Ability of black water portion of WMS to handle additional personnel (on a long-term basis) HTC_b - % of required black water (or sludge) holding tank capacity met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	100	100	--	100	100	100	--	--	100	--	--	100	--	100	--	--	100	--

Factor/Subfactor Ident. No.

M/E II - PERFORMANCE (Cont'd)

PERFORMANCE CHARACTERISTIC

332 Ability of gray water portion of WMS to handle additional personnel (on a long term basis)
HTC_g = % of required gray water (or sludge) hodling tank capacity met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	55	64	64	64	100	100	64	--	64	64	64	100	--	64	64	64	100	--

M/E IV - PERSONNEL SAFETY

SAFETY CHARACTERISTIC

21 Hazard of explosive potential for operator/maintainer due to inherent WMS design.

I - Installation Index (for personnel safety)

(a) Likelihood of hazardous situation is not increased due to location of any portion of WMS.
(b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area.
(c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

22 Hazard of explosive potential for operator/maintainer due to procedural error/equipment failures of WMS.

I - Installation Index (for personnel safety)

(a) Likelihood of hazardous situation is not increased due to location of any portion of WMS.
(b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area.
(c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

31 Hazard of fire ignition potential due to inherent WMS design

I - Installation Index (for personnel safety)

(a) Likelihood of hazardous situation is not increased due to location of any portion of WMS.
(b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area.
(c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

32 Hazard of fire ignition potential due to procedural errors/equipment failures of WMS.

I - Installation Index (for personnel safety)

(a) Likelihood of hazardous situation is not increased due to location of any portion of WMS.
(b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area.
(c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 9 of 10

M/E V - HABITABILITY

Factor/Subfactor Ident. No.	HABITABILITY CHARACTERISTIC
41	Heat generation for nearby personnel[1] due to inherent WMS design I = Installation index (for heat) (a) Location of WMS is not likely to raise heat level due to proximity to working and berthing areas. (b) Location of WMS is likely to raise heat level due to proximity to working and berthing areas. [1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

42	Heat generation for nearby personnel[1] due to procedural errors/equipment failures of WMS I = Installation index (for heat) (a) Location of WMS is not likely to raise heat level due to proximity to working and berthing areas. (b) Location of WMS is likely to raise heat level due to proximity to working and berthing areas. [1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

5	Noise level for personnel in vicinity of WMS[1] I = Installation index (for noise) (a) Location of WMS is not likely to raise noise level due to proximity to working and berthing areas. (b) Location of WMS is likely to raise noise level due to proximity to working and berthing areas. [1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

6	Vibration levels for nearby personnel[1] produced by WMS machinery I = Installation index (for vibration) (a) Location of WMS is not likely to raise vibration level due to proximity to working and berthing areas. (b) Location of WMS is likely to raise vibration level due to proximity to working and berthing areas. [1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel PAMLICO (160') - New Const. Sheet 10 of 10

Factor/Subfactor Ident. No.	M/E VI - RELIABILITY RELIABILITY CHARACTERISTIC																	
22	Extent of WMS configuration redundancy WMS equipment requirements.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data						- Presented on WMS Equipment Requirements Data Form -													

	M/E VII - MAINTAINABILITY MAINTAINABILITY CHARACTERISTIC																	
131	Accessibility of replaceable WMS components I - Installation index (for accessibility) (a) High degree of physical clearance around WMS equipment. (b) Moderate degree of clearance around WMS equipment. (c) Very tight, i.e., very little clearance around WMS equipment.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	c	b	b	b	b	b	b	b	c	b	b	b	b	b	b

CONCLUDING REMARKS

The following are points of consideration and observation relevant to this vessel, some of which have been included in the shipcheck observations, and are reiterated for emphasis and convenience. It should be noted that the vessel was under construction during most of this study period and circumstances did not permit conducting a shipcheck. Instead, the ship's drawings were used.

(a) The vessel is fitted with a system different from the other candidate vessels studied; i.e. it has a CHT system, but the flushing medium is fresh water (instead of sea water) and the collection system is via a vacuum tank. The collection and holding tanks and vacuum equipment are all located in the Auxiliary Machinery Room (2-94-0-E). The piping runs and space for equipment locations are convenient and well arranged, with separate runs of black and gray water mains, lending themselves readily adaptable to the similar WMS configurations studied. On the other hand for the non-vacuum collection systems and those requiring sea water flushing, modifications will be necessary as indicated in the shipcheck observations. Existing piping runs would be retained where size and function are suitable, but would have to be replaced by proper size piping where the alternative systems require. Existing piping connections would be reused where possible.

(b) Since there was no actual shipcheck possible, it can only be assumed from the ship's general arrangement drawings that access to ship the WMS equipment aboard can be by normal cuts in the deck or vessel's side. If there is any reason why access must be via cuts in the ship's side where fuel oil tanks are located, the tanks will have to be washed and gas freed before any hot work can be done.

(c) Since there was no actual shipcheck possible, it is not known if the stores and parts type stowage arrangement in the Storage Space (2-79-0-A) just forward of the Auxiliary Machinery Room can be transferred to another location. As indicated in the "shipcheck" observations, the viability of many of the wastewater management systems under consideration depends on the major allocation of space in that compartment. Therefore, this would have to be determined from an actual survey of shipboard conditions. The available arrangement drawings convey a favorable impression, but this would remain to be verified.

(d) The vessel is fitted with trim tanks which seemingly could be used for weight compensation. Otherwise there are no ballast provisions.

(e) The vessel is fitted with all support systems with the exception of the sea water flushing system mentioned above. In addition, the fire protection and ventilation systems would probably require modification to suit the systems employing incinerating and other heat producing equipment.

APPENDIX A

PRELIMINARY INSTALLATION ANALYSIS

PAMLICO (160')

New Construction

Vessel Characteristic	Data
Class	WLIC - 800
Type	Construction Tender (Inland)
Crew Size	13
Home Port	New Construction (Intended for Operation in Depot Corpus, Texas)

SUMMARY OF PRELIMINARY INSTALLATION ANALYSIS RESULTS

PAMLICO (160')

WMS No.	TYPE: Coll/Trans Subsys (Black)	TYPE: Treatment/Disposal Subsystem: Black	TYPE: Treatment/Disposal Subsystem: Gray	SYSTEM ACCEPTABILITY FOR INSTALLATION(1)
1	Gravity Collect.	Holding Tank	Holding Tank	Yes
2	Oil Recircul. (Chrysler)	Chrysler + Hld Tnk	Holding Tank	Yes
3		Chrysler + Incin.	Holding Tank	Yes
4	Gravity Collect. (Grumman)	Grum Flow Thru+HldTk	Holding Tank	Yes
5		Grumman Flow Thru + Holding Tank		Yes
6	Gravity Collect.	Holding Tank	Grum Flow Thru+HldTnk	Yes
7	Gravity Collect. (Grumman)	Grum Flow Thru+Incin.	Holding Tank	Yes
8		Grumman Flow Thru + Incinerator		Yes
9	Vacuum Collect. (Jered)	Holding Tank(2)	Holding Tank	Yes
10		Incinerator	Holding Tank	Yes
11		GATX Evap.	Holding Tank	Yes
12		Holding Tank(3)	Grum Flow Thru+Hld Tnk	Yes
13		Incinerator	Grum Flow Thru + Incin.	Yes
14	M/T Pump Collect. (GATX)	Holding Tank	Holding Tank	Yes
15		Incinerator	Holding Tank	Yes
16		GATX Evap.	Holding Tank	Yes
17		Holding Tank	Grum Flow Thru+Hld Tnk	Yes
18		Incinerator	Grum Flow Thru + Incin.	Yes

(1) Based on:
- Information contained in available vessel plans.
- WMS installation requirements.
- WMS installation criteria and guidelines.

(2) Two subchoices available for WMS No. 9 as follows:
- 9a - Concentrated black water transferred from VCT to holding tank (acceptable for all vessels).
- 9b - Concentrated black water held in VCT (acceptable for Point Herron only).

(3) Two subchoices available for WMS No. 12 as follows:
- 12a - Concentrated black water transferred from VCT to holding tank (acceptable for all vessels).
- 12b - Concentrated black water held in VCT (acceptable for Point Herron only).

PERTINENT VESSEL INFORMATION

PAMLICO (160')

Crew: 13 men

Sanitary Fixtures: 4 Waterclosets
1 Urinal
4 Showers
5 Lavatories

Existing Arrangement:

(a) All sanitary flushing is with fresh water.

(b) One (1) vacuum collection tank (approx. 300 gallons) with two (2) vacuum pumps, one (1) seal water vacuum tank, and two (2) sewage pumps, all grouped together on the ship's centerline at the forward end of the Auxiliary Machinery Room (2-94-O-E).

(c) All gray water and black water is collected in the vacuum collection tank (VCT) through separate mains. Galley and turbid drains combine upstream of a gray water transfer valve which regulates their flow to the VCT. Galley and turbid drain mains can also each independently drain overboard by gravity (before their combination upstream of the aforementioned transfer valve).

(d) The vacuum collection tank can be discharged overboard or up to hose connections port and starboard on deck for transfer to shore. Normally this is accomplished by the sewage pumps which are fitted in duplicate.

Vessel: PAMLICO (160')

WMS No. 1 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	3,419 gal. (457 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The required black water holding tankage apparently can be met by installing the tank in the Auxiliary Machinery Room (2-94-O-E) in the area presently occupied by the vacuum collection tank and associated equipment. Since the holding tank configuration would be controlled by ship support structure (stanchions, beams, etc.) some minor relocations of equipment may have to be accomplished.

The required gray water holding tankage apparently cannot be fully met. Approximately 900 cubic feet (6,730 gal.) can apparently be accommodated in the Storage Space (2-79-O-A) just forward of the Auxiliary Machinery Room. The gray water overboard pumps would be located in the same compartment. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 2 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Sludge Holding Tank for Sewage/Holding Tank for Gray Water

	Required
Sewage Holding Tank	638 gal. (85 cu.ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu.ft.)
Chrysler Model and Quantity	One (1) - A

Discussion

The system installation appears to be acceptable subject to certain limitations.

The required black water holding tankage apparently can be met by installing the tank in the Auxiliary Machinery Room (2-94-O-E) just to starboard of the area presently occupied by the vacuum collection tank. The sewage overboard pumps would be located adjacent to the tank. The Chrysler Separation Tank and the Pressurization and Fluid Maintenance Package would also be located in the Auxiliary Machinery Room, in the location presently occupied by the vacuum collection tank and associated pumps. Slight modification of the area may be required to suit the arrangement.

The required gray water holding tankage cannot be fully met. As in the case of System No. 1, approximately 900 cubic feet (6730 gal.) can apparently be accommodated in the Storage Space (2-79-O-A) just forward of the Auxiliary Machinery Room. The overboard pumps would also be located in the tank compartment. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 3 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Incinerator for Sewage/Holding Tank for Gray Water

	Required
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Sludge Ejection Tank	30 gal. (4 cu. ft.)
Chrysler Model and Quantity	One (1)-A
Incinerator Model and Quantity	One (1)-A

Discussion

The system installation appears to be acceptable subject to certain limitations.

The Chrysler MSD components, sludge ejection tank, and associated pumps, can apparently be located in the forward end of the Auxiliary Machinery Room in the location presently occupied by a vacuum collection tank and pumps.

The incinerator can apparently be fitted just to starboard of the Chrysler components. The incinerator stack will have to run aft into the Engine Room and up to the weather along with the existing smoke pipes. The fuel oil day tank will be fitted to suit the incinerator location.

This arrangement will probably require minor relocations (e.g. the workbench).

The required gray water holding tankage apparently cannot be fully met. It will be limited to the amount and location as indicated for System Nos. 1 and 2. The overboard pumps would be located near the tank. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 4 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Black Water/ Holding Tank for Gray Water

	Required
Sanitary Influent Surge Tank	68 gal. (9 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Sludge Holding Tank	285 gal. (38 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The Grumman structure height and the apparent available deck height in the Auxiliary Machinery Room may produce a slight interference since they are just about the same dimension. The structure could possibly fit in the area presently occupied by the vacuum collection tank and associated equipment. The sanitary influent surge tank, the surge tank pump, the overboard dishcarge pump, the sludge transfer pump and the sludge holding tank would be grouped on the aft and starboard sides of the Grumman structure. The existing workbench would have to be relocated.

The required gray water holding tankage cannot be fully met. It will be limited to the amount and location as indicated for System Nos. 1, 2 and 3. The overboard pumps would be located near the tank. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 5 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Combined Black and Gray Waters

	Required
Influent Surge Tank	268 gal. (36 cu. ft.)
Sludge Holding Tank	1,099 gal. (147 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations.

For the most part, the system with its possible limitations is similar to System No. 4, except that there is no separate galley and turbid holding tank required. The components would be located in the Auxiliary Machinery Room generally as indicated for System No. 4. The larger influent surge tank and sludge holding tank with their pumps would be located to suit on the aft and starboard sides of the Grumman structure.

Minor modifications to the existing arrangement would probably be required.

Vessel: PAMLICO (160')

WMS No. 6 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G/T Influent Surge Tank	200 gal. (27 cu. ft.)
Sewage Holding Tank	3,419 gal. (457 cu. ft.)
Sludge Holding Tank	814 gal. (109 cu. ft.)
Optional Combined Sewage/Sludge Holding Tank	4,233 gal. (566 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations. Two arrangements are possible.

(a) The Grumman structure would be located in the Auxiliary Machinery Room in the space occupied by the existing vacuum collection tank. However, the structure height could be at variance with the available deck height. The galley and turbid influent surge tank, surge tank pump, sludge holding tank, and sludge transfer pump would be located on the aft side of the Grumman structure. The sludge holding tank would be located to starboard of the Grumman structure. The G/T influent surge tank would have to be pumped to the sewage holding tank.

There is apparently insufficient space available in the Auxiliary Machinery Room to also include the required sewage holding tank. Therefore, it would be located in the Storage Space (2-79-O-A) immediately forward, together with the overboard pumps.

To accommodate the installation, some modifications to the existing arrangement would be necessary.

(b) The installation of an optional combined sewage/sludge holding tank is not considered practicable. Although the required tank volume could apparently be accommodated in the Storage Room (2-79-O-A), the tank configuration and its location relative to the Grumman centrifuge and ozone reactor does not fulfill the requirement for gravity drainage of the centrifuge and proximity for the ozone reactor for foam drainage.

(c) The alternative arrangement is to reverse the compartment locations of the components; i.e. locate the sewage holding tank and overboard pumps in the Auxiliary Machinery Room (as in System No. 1) and the remaining system components in the Storage Space immediately forward.

Vessel: PAMLICO (160')

WMS No. 7 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Black Water/Holding Tank for Gray Water

	Required
Gray Water Holding Tank	9,770 gal. (1306 cu. ft.)
Sewage Influent Surge Tank	68 gal. (9 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Units	One (1)
Incinerator	One (1) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations.

For the most part, the system is basically similar to System No. 4, with the exception that there is no sludge holding tank, but an incinerator has been added to the Grumman structure. The system component orientations in the Auxiliary Machinery Room would be modified slightly from that of System No. 4 due to the additional space required by the incinerator burner. However, the displacements would be minor. Existing equipment would probably require minor reorientation (e.g. the workbench). The incinerator stack would have to be led aft into the Engine Room and up to the weather with the existing exhaust pipes.

The required gray water holding tankage cannot be fully met. It will be limited to the same quantity and location as in Systems 1, 2, 3 and 4 (approximately 6,730 gallons). The overboard pumps would be located near the tank. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 8 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Combined Black and Gray Waters

	Required
Influent Surge Tank	268 gal. (36 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Units	One (1)
Incinerators	One (1) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations.

The system is similar in many respects to System No. 5, except that an incinerator is required in lieu of a sludge holding tank. The equipment would be located in the Auxiliary Machinery Room in the space presently occupied by the vacuum collection tank. Due to the additional space required by the incinerator burner, the influent surge tank would be located probably to starboard of the Grumman structure. The surge tank pump and the overboard pumps would be located near the influent tank. The fuel oil day tank would be located in the vicinity of the Grumman structure, probably along the forward bulkhead of the compartment, to starboard of the ship's centerline.

The incinerator stack would have to be led aft to the Engine Room and up to the weather along with the existing exhaust piping.

Vessel: PAMLICO (160')

WMS No. 9 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	30 gal. (4.4 cu. ft.)
Sanitary Holding Tank	1,070 gal. (143 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered.

The sanitary holding tank would be located in the Auxiliary Machinery Room in place of the existing vacuum collection tank. The overboard pumps and the new vacuum collection tank would be located aft of the sanitary holding tank. The vacuum pump assembly would be adjacent to the collection tank.

The required gray water holding tankage apparently cannot be fully met. It would be limited to approximately 6,730 gallons in a tank to be located in the Storage Space just forward of the Auxiliary Machinery Room, similar to System Nos. 1, 2, 3, 4 and 7. The overboard pumps would be located near the tank. This would eliminate the use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 10 JERED Reduced Volume Flush Vacuum Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	120 gal.
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Incinerator Feed Tank (Sludge)	(6.5 cu. ft.)
Fuel Oil Day Tank	28 gal. (3.8 cu. ft.)
Incinerator	One (1) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered.

The vacuum collection tank, incinerator feed tank (sludge), vacuum pump, and overboard pump would be located in the Auxiliary Machinery Room in place of the existing vacuum collection tank and associated equipment. The new equipment would be oriented generally as presently arranged. The incinerator, blower and fuel oil day tank would be located immediately to starboard of the vacuum collection equipment. The incinerator stack would have to be led aft to the Engine Room and up to the weather along with the existing exhaust piping.

The required gray water holding tankage apparently cannot be fully met. It would be limited to approximately 6,730 gallons in a tank to be located in the Storage Space just forward of the Auxiliary Machinery Room, similar to System Nos. 1, 2, 3, 4, 7 and 9. The overboard pumps would be located near the tank. This would eliminate use of the Storage Space for any other purposes.

Minor equipment relocations (e.g. workbench) would be necessary.

Vessel: PAMLICO (160')

WMS No. 11 JERED Reduced Volume Flush Vacuum Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	30 gal. (4.4 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Evaporator (GATX)	One (1) - 40 gal.
Catalytic Oxidizer	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered.

The vacuum collection tank and various pumps (other than the galley and turbid tank overboard pumps) would be located in the Auxiliary Machinery Room where the existing vacuum collection equipment is presently fitted.

The evaporator and the catalytic oxidizer would be located to starboard of the vacuum collection tank and pumps.

Minor equipment relocation (e.g. workbench) would be necessary.

The required gray water holding tankage apparently cannot be fully met. It would be limited to approximately 6,730 gallons in a tank located in the Storage Space just forward of the Auxiliary Machinery Room as in System Nos. 1, 2, 3, 4, 7, 9 and 10. The overboard pumps would be located adjacent to the tank. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 12 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G/T Influent Surge Tank	200 gal. (27 cu. ft.)
Sludge Holding Tank	814 gal. (109 cu. ft.)
Sewage Vacuum Collection Tank	30 gal. (4.4 cu. ft.)
Sewage Holding Tank	1,070 gal. (143 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered.

The sewage vacuum collection tank, vacuum pump, sewage holding tank, and sewage overboard pumps would be located where the existing vacuum collection equipment is fitted in the Auxiliary Machinery Room.

The galley and turbid influent sludge tank and associated pumps would be located to starboard of the sewage collection and holding tanks.

Since the sludge holding tank should be located near the Grumman structure to receive centrifuge and ozone reactor drainage, and since there is apparently insufficient space to accommodate the Grumman structure in the Auxiliary Machinery Room without crowding and causing extensive existing equipment relocations, the apparent best arrangement is to try to fit the Grumman structure and sludge holding tank in the Storage Space forward of the Auxiliary Machinery Room. The deck height availability could offer some problem for the height of the Grumman unit. The sludge holding tank transfer pump would be located near the tank.

Vessel: PAMLICO (160')

WMS No. 13 JERED Reduced Volume Flush Vacuum Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required
Gray Water Surge Tank	200 gal. (27 cu. ft.)
Vacuum Collection Tank	30 gal. (4.4 cu.ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu.ft.)
Grumman Unit	One (1)
Incinerator	One (1) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered.

The Grumman structure would be located in the Auxiliary Machinery Room in the space presently fitted with a vacuum collection tank and associated equipment. The fuel oil day tank would be located near the Grumman structure, preferably on the forward bulkhead, either to port or starboard of the ship's centerline. The incinerator stack would have to be led aft to the Engine Room and up to the weather along with the existing exhaust piping.

The gray water surge tank, the surge tank pump and the overboard pump would be located to starboard of the Grumman structure.

The sewage vacuum collection tank and vacuum pump would be located just aft of the Grumman structure, either to port or starboard of the ship's centerline, which is more advantageous.

The principal limitation would be the ability of the available deck height to accommodate the height of the Grumman structure.

Vessel: PAMLICO (160')

WMS No. 14 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	1,099 gal. (147 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The sewage holding tank would be located in the Auxiliary Machinery Room in the space where the existing vacuum collection equipment is fitted. The sewage overboard pumps would be located just aft of the sewage holding tank.

The required gray water holding tankage apparently cannot be fully met. By utilizing the maximum available room in the Storage Space just forward of the Auxiliary Machinery Room, it is estimated that approximately 7,630 gallons can be held. This would require that the gray water overboard pumps be located in the Auxiliary Machinery Room, to starboard of the new sewage holding tank. This arrangement would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 15 GATX Reduced Volume Flush M/T Pump Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Incinerator Feed Tank	50 gal. (6.7 cu. ft.)
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Fuel Oil Day Tank	28 gal. (3.8 cu. ft.)
Incinerator	One (1) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations.

The incinerator with its feed tank, feed pump, blower, and overboard pump would be located in the Auxiliary Machinery Room in the space presently occupied by the vacuum collection equipment. The incinerator control box and the fuel oil day tank would be mounted on the forward bulkhead of the room and as close as practicable to the incinerator.

The incinerator stack would have to be led aft into the Engine Room and up to the weather along with the existing exhaust piping.

The required gray water holding tankage apparently cannot be fully met. By utilizing the maximum available room in the Storage Space just forward of the Auxiliary Machinery Room, it is estimated that approximately 7,630 gallons can be held. This would require that the gray water overboard pumps be located in the Auxiliary Machinery Room, to starboard of the incineration equipment installation. This would eliminate use of the Storage Space for any other purposes.

Vessel: PAMLICO (160')

WMS No. 16 GATX Reduced Volume Flush M/T Pump Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Galley/Turbid Holding Tank	9,770 gal. (1306 cu. ft.)
Evaporator (GATX)	One (1) - 40 gal.
Catalytic Oxidizer	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The system is similar to System No. 11 except that black water here is collected via macerating/transfer pumps in lieu of vacuum collection.

The evaporator, catalytic oxidizer, sludge pump and controls would be located in the Auxiliary Machinery Room in the space presently occupied by the vacuum collection equipment. The oxidizer and controls would probably be mounted on the bulkhead just forward of the evaporator.

The required gray water holding tankage apparently cannot be fully met. By utilizing the maximum available room in the Storage Space just forward of the Auxiliary Machinery Room, it is estimated that approximately 7,630 gallons can be held. This would require that the gray water overboard pumps be located in the Auxiliary Machinery Room, to starboard of the evaporation equipment installation. This would eliminate the Storage Space from use for any other purposes.

Vessel: PAMLICO (160')

WMS No. 17 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
Sewage Holding Tank	1,099 gal. (147 cu. ft.)
G/T Influent Surge Tank	200 gal. (27 cu. ft.)
Sludge Holding Tank	814 gal. (109 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The system is similar to System No. 12 except that black water is collected here via macerator/transfer pumps in lieu of a vacuum collection system.

The sewage holding tank, its overboard discharge pumps, the G/T influent surge tank and the surge tank pumps would be located where the existing vacuum collection equipment is fitted in the Auxiliary Machinery Room.

The Grumman structure, the sludge holding tank and the sludge transfer pump would be located in the Storage Space forward of the Auxiliary Machinery Room for the same reasons of space availability and functional relationship as indicated for System No. 12. The limitations are also as indicated for that system.

Vessel: PAMLICO (160')

WMS No. 18 GATX Reduced Volume Flush M/T Pump Collection/Grumman Flow Through System for Gray Water/Incincerator for both Concentrated Black Water and Gray Water Sludge

	Required
Black Water Surge Tank	26 gal. (3.5 cu. ft.)
Gray Water Surge Tank	200 gal. (27 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Unit	One (1)
Incinerator	One (1) Thiokol

Discussion

The system appears to be acceptable subject to certain limitations.

The system is similar to System No. 13 except that black water is collected here via macerator/transfer pumps in lieu of a vacuum collection system. The remaining equipment would be located as indicated for System No. 13. In addition, the black water surge tank and its pumps would be located just aft of the Grumman structure, either to port or to starboard of the ship's centerline, whichever is more advantageous.

The principal limitation for this system is the same as for System No. 13.

* U.S.G.P.O. 727-085/1302-1655